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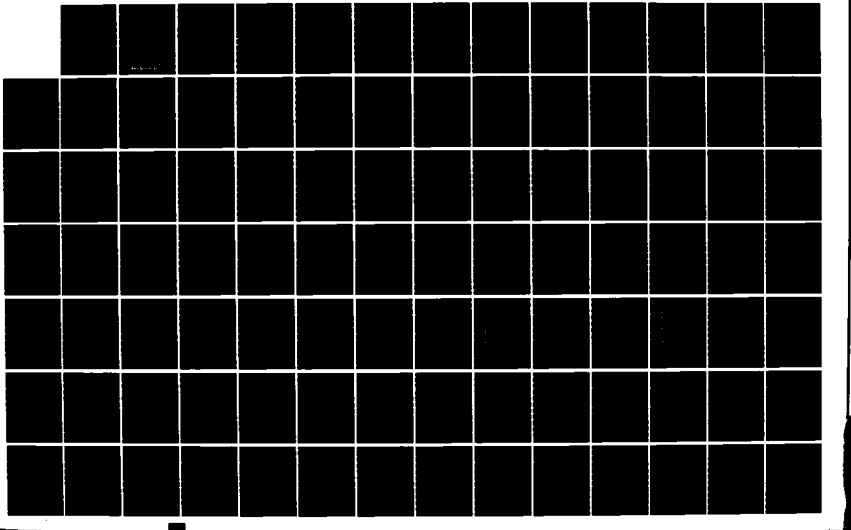

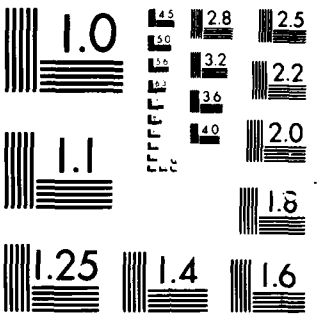

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U.S. ARMY MICOM SCIENTIFIC and ENGINEERING SUPPORT

COMPUTATIONAL CAPABILITIES REQUIREMENTS ANALYSIS

STUDY REPORT

VOLUME II REQUIREMENTS ANALYSIS TECHNICAL REPORT

NOVEMBER 15, 1985

Prepared For: Commander
US Army Missile Command
ATTN: AMSMI-WPA
Redstone Arsenal, AL 35898-5170

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The basic questions addressed were what is the total near and long-term scientific and engineering computing requirements and what is the best way to effectively meet the requirements. The study identified and analyzed the requirements, developed alternatives for satisfying the requirements, and recommended cost effective approaches to satisfying the near and long-term requirements. The findings and recommendations were presented in an Executive Summary, Management Overview, and a Requirements Analysis Technical Report.

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U.S. ARMY MICOM SCIENTIFIC AND ENGINEERING SUPPORT
COMPUTATIONAL CAPABILITIES REQUIREMENTS ANALYSIS

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2.0 REQUIREMENTS ANALYSIS

This document is Volume II of a Scientific and Technical report prepared for the U.S. Army Missile Command (MICOM) as a result of contract number DAAH03-85-C-0032. Inter Systems Inc. (ISI) was selected by MICOM to conduct a command-wide Scientific and Engineering Computing Requirements Analysis to assess the Command's current, near-term (5 years) and long-term (10 years) Requirements, and, to determine the best approach for satisfying the requirements over the long-term. The study began in February 1985 and was completed during November 1985.

ISI attempted to collect data from a cross-section of the Scientific and Engineering User Community, through the distribution and collection of a series of three data collection instruments. Many face-to-face interviews were conducted with representatives of twenty-five MICOM organizations. A tremendous effort was made by ISI to collect data from all twenty-five organizations at an Organizational Level, at an Application Level and at the User Level. There was an extremely high level of resistance to the data collection effort, due to local politics. When the data collection process was terminated by ISI in August 1985, we had at least obtained some useable data on the major MICOM organizations from 107 Organizational Level Questionnaires, 70 Application Level Questionnaires and 148 User Level Questionnaires.

Although the number of questionnaires seems to be good, considering the short time that could be spent on the data collection effort, the data supplied on the questionnaires left a lot to be desired. Accurate information, on equipment inventory, projected ADPE acquisitions and associated costs, current and future applications, actual numbers of current

and anticipated Computer Users, and specific requirements, was difficult to extract from many organizations. But, as the study progressed and more of the working-level Users were interviewed, a better indication of the overall requirements surfaced.

This document attempts to pull together all the relevant information and facts that were discovered during the course of the study. This document provides an analysis of the current environment that covers hardware, software and telecommunications capabilities, along with an analysis of the User Community structure. It provides a brief investigation of the Past and a brief look into the Future. It formulates a definition of the problem and provides a functional analysis of the requirements. It formulates a quantification of the requirements and analyzes system implementation alternatives for meeting the requirements. It provides specific recommendations, around which, the Master Plan and Implementation Strategy were developed. Implementation cost estimates were developed around the recommended Master Plan and Implementation Strategy, which was developed as a result of this Requirements Analysis. The Master Plan and Implementation Strategy and the associated cost estimates are found in Volume I Sections 1.9 and 1.10, respectively.

2.1 Current Environment Analysis

The MICOM Scientific and Engineering Community is currently supported by a cadre of Scientific and Engineering computing equipment provided by over 107 different equipment vendors. Over 220 different canned software packages are used across somewhere between 441 and 722 physically different mainframes, minicomputers and microcomputers. The 441 computers were identified on the Organizational Level Questionnaires. The additional

281 computers were identified from a DARCOM ADPE Inventory Report. Some overlap may exist between the two inventories; but, there are about another 50 to 100 minis and micros that people indicated the existence of, that probably don't appear on either the data collected or in the DARCOM Inventory. So, there very well may be about 722 computers of various sizes on the Arsenal. A completely reconciled inventory also was not part of the Scope of Work for this contract. Overall telecommunications support is provided over a variety of communications equipment, at line speeds of 300, 1200, 2000, 2400, 4800 and 9600 BAUD. About 27% of the communications circuits (i.e., 63 of 235) are currently connected to the S&E Computing Facility. The number of circuits required for the S&E Computing Facility is expected to more than double, after the current hardware is replaced.

Section 2.1 is organized into nine major sub-sections: Section 2.1.1 provides an analysis of the Computer Hardware that is currently used; Section 2.1.2 provides an analysis of the types of Computer Software that is currently used; Section 2.1.3 reviews the current Telecommunications Hardware Capabilities; Section 2.1.4 reviews the current Telecommunications Software Capabilities; and Section 2.1.5 reviews the current Terminal Support Capabilities; Section 2.1.6 reviews the current Graphics Devices Support Capabilities; Section 2.1.7 reviews the current Peripheral Devices Support Capabilities; Section 2.1.8 reviews the current Communications Lines/Circuits Support Capabilities; and Section 2.1.9 Analyzes the Current S&E User Community.

2.1.1 Current Computer Hardware Analysis

According to the DARCOM ADPE Inventory report, as of 31 October 1984, the MICOM Data Processing Installation (DPI) had 253 Computer Configurations containing 281 Central Processing Units (CPU), which service over 100 Data Processing Activities (DPA). The data collected from the survey indicated the existence of 441 computers. Of the 441 computers identified by the organizations during the survey, 19 were identified by the survey respondents as mainframes, 73 as minicomputers and 349 as microcomputers. Due to the high number of computers that haven't been reported to us, or have been installed since the Organizational Level Questionnaires were filled out; we feel that it is safe to assume that there exists about 722 computers on the Arsenal. About half to three quarters of the computers found in the Functional Directorates are believed to be used strictly for pure S&E Work. About half of the computers found in the Project Management Offices are believed to be used for S&E related Work and the other half probably support pure Business Data Processing Applications.

Figure 2-1 provides a summarization report of the data provided on the DARCOM ADPE Inventory Report by Vendor and Configuration Name. The report counts the number of configurations and sums the purchase price, monthly maintenance and monthly rental costs by Vendor and Configuration Name. An analysis of the report shows that 53% of the configurations are Hewlett Packard; 10% are Digital Equipment Corporation; Control Data, Data General, Electronic Associates, Harris, Perkin-Elmer, Tektronix, Sperry-Univac, Varian and Wang collectively, represent 8% of the configurations. The other 29% of the configurations are scattered across more than 16 different vendors. About 13% (32) of the configurations are identified as being "REMOTE", which

probably identifies Remote Job Entry (RJE) workstations. RJE workstations are used to submit batch jobs to the Central Computing site and to retrieve and print the output of batch jobs on remote high-speed printers located in the User's work areas.

About 53 of the 221 (253-32) computer configurations are believed to support predominantly "Business" oriented applications; but, some members of the S&E User Community use the "Business" machines for S&E related work because of the availability of virtual memory and relatively fast central processing units.

Further analysis of the DARCOM Inventory Report, showed that 235 out of the 281 computers in the inventory were installed at MICOM during 1975 to 1984. Between 1975 and 1979, 102 computers were installed at MICOM; and another 133 computers were installed, between 1980 and 1984. The majority of the 235 computers installed, during 1975 to 1984, are powerful minicomputers. Many of the minicomputers installed since 1980, boast near mainframe level computing power. In terms of a MIPS rating (millions of instructions per second), the minicomputers being used boast ratings between .25 and 4 MIPS. The CDC and Sperry Univac mainframes utilized are about 3 MIPS machines. Collectively, the computers in the inventory report represent approximately 140.6 MIPS of processing power, which is over twenty times the computing power that was used during the early 1970's. Approximately 205.3 MIPS of computing power exist in the 441 other computers that were identified during the data collection effort.

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COMPUTER CONFIGURATION SUMMARY
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	CONFIGURATION NAME	NUMBER OF CONFIGURATIONS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
99	99 REMOTE	1	1,736,093	13,861	13,869
*TOTAL 99		1	1,736,093	13,861	13,869
ADC	ADCAD4	1	401,000	0	0
*TOTAL ADC		1	401,000	0	0
AMR	AMR1010	1	31,600	0	0
*TOTAL AMR		1	31,600	0	0
APM	APM2	1	1,800	0	0
*TOTAL APM		1	1,800	0	0
CBM	CBM2001	7	19,500	0	0
	CBM8032	1	3,300	0	0
*TOTAL CBM		8	22,800	0	0
CCC	CCCDPD24	1	156,050	0	0
*TOTAL CCC		1	156,050	0	0
CDC	CDC160A	1	73,464	0	0
	CDC6600	1	3,410,480	20,934	3,195
	CDCCYBER74	1	673,748	16,522	2,523
*TOTAL CDC		3	4,157,692	37,456	5,718
DEO	DEOPDP1104	1	75,300	0	0
*TOTAL DEO		1	75,300	0	0
DEC	DECLSI11	2	24,393	282	0
	DECPDP11	4	688,341	3,185	0
	DECPDP1103	2	68,819	211	0
	DECPDP1110	1	63,243	717	0
	DECPDP1120	1	446,712	1,014	0
	DECPDP1134	6	738,885	3,198	0
	DECPDP1140	1	72,875	510	0
	DECPDP1145	1	33,200	0	0
	DECPDP1155	1	194,530	0	0
	DECPDP1170	2	492,111	2,267	570

Figure 2-1 Computer Configuration Summary

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COMPUTER CONFIGURATION SUMMARY
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	CONFIGURATION NAME	NUMBER OF CONFIGURATIONS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
DEC	DECPDP8E	1	12,000	66	0
	DECVX11780	3	1,048,504	5,776	0
*TOTAL DEC		25	3,883,613	17,226	570
DGC	DGC312	1	50,369	0	0
	DGCECLS130	1	107,322	0	0
	DGCNOVA3	1	79,101	0	0
*TOTAL DGC		3	236,792	0	0
EAI	EAIPACER	1	149,225	0	0
*TOTAL EAI		1	149,225	0	0
HCS	HCSSLASH6	1	1,350,116	0	0
*TOTAL HCS		1	1,350,116	0	0
HPC	HPCHP100	1	82,855	614	0
	HPCHP1000	16	1,332,077	3,409	0
	HPCHP100OF	1	133,400	515	0
	HPCHP125	1	3,000	0	0
	HPCHP2100A	7	230,504	1,807	0
	HPCHP2100C	1	38,644	304	0
	HPCHP2100S	1	121,686	0	0
	HPCHP2116B	1	28,775	0	0
	HPCHP2116C	1	12,550	0	0
	HPCHP213E	1	32,950	161	0
	HPCHP21MX	7	653,142	2,299	0
	HPCHP2100S	1	310,522	0	0
	HPCHP3000	3	208,928	970	0
	HPCHP3052A	3	60,330	148	0
	HPCHP5427A	2	133,396	0	0
	HPCHP5451B	3	407,293	0	0
	HPCHP5934A	1	65,000	0	0
	HPCHP830A	1	16,339	107	0
	HPCHP85A	4	16,692	0	0
	HPCHP9030C	1	65,597	367	0
	HPCHP91001	1	5,000	0	0
	HPCHP9100A	1	5,000	0	0
	HPCHP9100B	2	19,600	75	0
	HPCHP945T	1	31,000	120	0
	HPCHP9600A	2	163,578	667	0
	HPCHP9603A	1	120,674	0	0

Figure 2-1 Computer Configuration Summary (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COMPUTER CONFIGURATION SUMMARY
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	CONFIGURATION NAME	NUMBER OF CONFIGURATIONS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
HPC	HPCHP9810A	2	14,146	0	0
	HPCHP9820A	5	45,027	258	0
	HPCHP9821A	2	27,788	94	0
	HPCHP9825A	8	106,093	152	0
	HPCHP9825S	1	8,350	0	0
	HPCHP9826A	1	76,660	0	0
	HPCHP9830A	20	329,009	1,161	0
	HPCHP9836	1	26,000	0	0
	HPCHP9845A	3	100,871	534	0
	HPCHP9845B	8	339,921	840	0
	HPCHP9845C	2	109,869	434	0
	HPCHP9845T	17	866,613	4,262	0
*TOTAL HPC		135	6,348,879	19,298	0
IBM	IBM1401	1	366,279	760	0
	IBM4341	3	1,539,332	7,977	25,626
	IBMSYS7	4	289,970	2,987	0
*TOTAL IBM		8	2,195,581	11,724	25,626
IEL	IELMDS230	1	17,300	0	0
	IELMDS286	1	37,680	0	0
*TOTAL IEL		2	54,980	0	0
IMA	IMA8080	1	13,500	0	0
*TOTAL IMA		1	13,500	0	0
ITD	ITD832	1	264,259	2,176	0
*TOTAL ITD		1	264,259	2,176	0
ITE	ITEAS3/5	1	3,578,518	38,473	70,075
	ITEAS5/3	2	1,188,863	9,770	5,565
*TOTAL ITE		3	4,767,381	48,243	75,640
MOT	MOTM6800	4	69,327	0	0
*TOTAL MOT		4	69,327	0	0
NSR	NSRH2	1	4,350	0	0
*TOTAL NSR		1	4,350	0	0

Figure 2-1 Computer Configuration Summary (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COMPUTER CONFIGURATION SUMMARY
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	CONFIGURATION NAME	NUMBER OF CONFIGURATIONS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
PKE	PKE3242	3	766,917	4,735	0
	PKE3252	1	439,412	6,505	0
*TOTAL PKE		4	1,206,329	11,240	0
PLX	PLX25	1	.31,420	461	1,147
*TOTAL PLX		1	31,420	461	1,147
ROS	ROSTRS80	2	8,183	0	0
*TOTAL ROS		2	8,183	0	0
RWI	RWIAIM65	2	12,275	0	0
*TOTAL RWI		2	12,275	0	0
TEK	TEK3262	1	251,890	1,686	0
	TEK4052	1	18,075	274	0
	TEK4054	1	154,264	1,269	0
*TOTAL TEK		3	424,229	3,229	0
TEX	TEX990	1	1,000	0	0
*TOTAL TEX		1	1,000	0	0
UNI	UNI1100/81	1	2,772,896	10,100	0
*TOTAL UNI		1	2,772,896	10,100	0
VAR	VAR620I	1	634,695	9,246	0
	VARV77/600	1	88,660	2,360	0
*TOTAL VAR		2	723,355	11,606	0
VEG	VEGM2	1	40,418	0	0
*TOTAL VEG		1	40,418	0	0
WAN	WAN700	1	9,300	0	0
	WAN700B	1	8,203	0	0
	WAN720C	1	30,124	0	0
*TOTAL WAN		3	47,627	0	0

Figure 2-1 Computer Configuration Summary (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COMPUTER CONFIGURATION SUMMARY
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	CONFIGURATION NAME	NUMBER OF CONFIGURATIONS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
Y2	Y2 REMOTE	1	17,400	526	0
*TOTAL Y2		1	17,400	526	0
Y3	Y3 REMOTE	1	8,700	263	0
*TOTAL Y3		1	8,700	263	0
Y4	Y4 REMOTE	1	25,939	399	0
*TOTAL Y4		1	25,939	399	0
Y5	Y5 REMOTE	1	8,700	263	0
*TOTAL Y5		1	8,700	263	0
Y6	Y6 REMOTE	1	8,700	263	0
*TOTAL Y6		1	8,700	263	0
Y7	Y7 REMOTE	1	17,400	526	0
*TOTAL Y7		1	17,400	526	0
Y8	Y8 REMOTE	1	498,459	2,658	26,245
*TOTAL Y8		1	498,459	2,658	26,245
Y9	Y9 REMOTE	1	423,509	0	24,879
*TOTAL Y9		1	423,509	0	24,879
YA	YA REMOTE	1	72,442	844	0
*TOTAL YA		1	72,442	844	0
YB	YB REMOTE	1	30,771	407	0
*TOTAL YB		1	30,771	407	0
YC	YC REMOTE	1	107,535	890	0
*TOTAL YC		1	107,535	890	0
YD	YD REMOTE	1	68,422	824	0

Figure 2-1 Computer Configuration Summary (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COMPUTER CONFIGURATION SUMMARY
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	CONFIGURATION NAME	NUMBER OF CONFIGURATIONS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
*TOTAL YD		1	68,422	824	0
YE	YE REMOTE	1	72,683	587	0
*TOTAL YE		1	72,683	587	0
YF	YF REMOTE	1	33,389	407	0
*TOTAL YF		1	33,389	407	0
YG	YG REMOTE	1	74,114	317	0
*TOTAL YG		1	74,114	317	0
YH	YH REMOTE	1	23,039	0	0
*TOTAL YH		1	23,039	0	0
YI	YI REMOTE	1	69,184	10	3,168
*TOTAL YI		1	69,184	10	3,168
YJ	YJ REMOTE	1	42,562	798	0
*TOTAL YJ		1	42,562	798	0
YK	YK REMOTE	1	25,489	0	0
*TOTAL YK		1	25,489	0	0
YL	YL REMOTE	1	11,019	126	0
*TOTAL YL		1	11,019	126	0
YM	YM REMOTE	1	10,434	106	0
*TOTAL YM		1	10,434	106	0
YN	YN REMOTE	1	21,306	193	0
*TOTAL YN		1	21,306	193	0
YO	YO REMOTE	1	15,589	67	0
*TOTAL YO		1	15,589	67	0

Figure 2-1 Computer Configuration Summary (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COMPUTER CONFIGURATION SUMMARY
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	CONFIGURATION NAME	NUMBER OF CONFIGURATIONS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
YP	YP REMOTE	1	24,626	281	0
*TOTAL YP		1	24,626	281	0
YQ	YQ REMOTE	1	25,376	0	0
*TOTAL YQ		1	25,376	0	0
YR	YR REMOTE	1	17,200	0	2,082
*TOTAL YR		1	17,200	0	2,082
YS	YS REMOTE	1	21,395	272	1,038
*TOTAL YS		1	21,395	272	1,038
YT	YT REMOTE	1	55,704	0	0
*TOTAL YT		1	55,704	0	0
YU	YU REMOTE	1	29,200	0	0
*TOTAL YU		1	29,200	0	0
YY	YY REMOTE	1	153,531	1,733	4,851
*TOTAL YY		1	153,531	1,733	4,851
YZ	YZ REMOTE	1	3,415	10	0
*TOTAL YZ		1	3,415	10	0
TOTAL		253	33,205,302	199,390	184,833

Figure 2-1 Computer Configuration Summary (Cont'd)

The S&E Central Computing facility is composed of two large-scale computers: a CDC 6600, which was installed in 1971; and, a CDC CYBER 74 computer, which was installed in 1978. The CDC 6600 has been modified to support some special-purpose Real-Time hardware interfaces. It also runs a custom-built Real-Time Operating System, which supports the operation of the Real-Time hardware interfaces. The CYBER 74 runs the NOS/BE operating system. Both central processors share mass storage and tape devices. Both processors share a distributive data path, which permits workload leveling between the two systems. But, the CDC 6600 is predominantly used for Real-Time Applications, and the CYBER 74 handles general purpose Scientific and Engineering Applications. The Central Computing facility is used to support large-scale Database Management Applications, Number Crunching with Graphics Output Applications, Statistical Analysis Applications, System Simulation and Modeling Applications; and, a variety of Scientific and Engineering Applications in the areas of: *Aerospace*, *Chemical*, *Civil*, *Electrical*, *Human* Factors, Industrial, Material Science, Mechanical, Nuclear, Structural, General and Logistics Engineering; along with Program and Project Management Analysis, Operations Research, Chemistry and Physics, Mathematics and Statistics, and Lasers and Optics, to mention a few.

The many other small computing facilities, that are scattered throughout the Command, are used to support both special-purpose and general-purpose Scientific, Engineering, Computer-Aided-Design and Manufacturing, and day-to-day Business and Management Applications. Some of the more specialized application areas include: Automatic Test Equipment, Command and Control Communications, Guidance and Control, Data Acquisition, Instrument Control, Production and Process Control, Mechanical and Environmental Testing, Machine-Tool Control, Waveform Analysis, Linear Programming, AC Circuit Analysis,

Numerical Analysis and a variety of laboratory automation application areas. Some of the larger minicomputers support medium-scale real-time simulation, modeling, data acquisition and data reduction applications, along with all of the application areas that are supported on the mainframes; and, probably some other areas that did not surface during the course of this study. Some of the microcomputers support complete engineering drawing system requirements that include manipulation of two and three-dimensional structures; PC Board Layouts Design and Numerical Controlled Drilling; Electronic and other types of schematic drawings and materials lists; all with hardware and software interfaces for producing overhead slides, N/C drill tapes, high-resolution color graphics, printed outputs and storage of information on magnetic tape and disk. Other micros provide hardware and software interfaces used in Modal Analysis for Structural Dynamics (simple or complex vibration analysis); Signature Analysis to help solve noise, vibration and failure problems in rotating machinery; and Vibration Test Control capabilities to provide closed-loop digital control of a shaker with random, sine or transient signals.

In addition to the computing power that exists on the Arsenal to support the S&E Community, it is believed that a substantial computing workload is satisfied by a variety of inter-governmental agency and commercial timesharing service arrangements. An additional substantial computing workload is probably being performed on contractor machines and various University Computing Centers. The computing workload that is satisfied off the Arsenal is distributed across mainframe IBM and CDC and SPERRY-UNIVAC machines, CRAY machines and large DEC VAX machines. The actual extent of external computing support that is consumed by the S&E Community could not be determined during the course of this study. The cost of these timesharing arrangements also

could not be determined; although, they are believed to be quite substantial.

The current S&E Computing Environment at MICOM is, for the most part, technically and functionally obsolete. At the S&E Central Computing Facility, the mainframe CDC 6600 and the CYBER 74 machines are more than two generations old. They have relatively slow CPU speeds and have less central memory than is currently available on some microcomputers, that are available today. With the amounts of computing power that is currently distributed or planned to be distributed around the Arsenal, the current central mainframes are totally inadequate to meet any of the large memory and faster CPU application processing requirements that exist. Processor speeds and central memory capacities, on the order of magnitude of ten to twenty times the current capabilities, must be considered in order for the central facility replacement mainframes to be of any real value to the S&E User Community.

At the remotely located computer centers, most of the equipment is in need of either substantial upgrading of the memory capacity and addition of Central Processing Units to increase configuration thruput capabilities; or, complete consolidation and replacement of configurations by significantly greater capacities organized into a Distributed Hierarchical Data Processing Network Arrangement is required. Either, or both alternatives, can be used to bring adequate computing power to the End-Users.

The conclusion of the computer hardware analysis is that a full and comprehensive Scientific and Engineering Computing Environment Modernization Program should be initiated to ensure that a State-of-the-Art Computing Environment exists for the benefit of all of the S&E End-Users. Maintaining the Environment at the State-of-the-Art should be a top management priority.

2.1.2 Current Computer Software Analysis

The MICOM Scientific and Engineering Community is currently supported by over 220 different canned software packages, which run on or interface with over 107 different Vendor's computers and scientific instruments. The software used or desired can broadly be classified into eleven major categories: DATABASE MANAGEMENT SYSTEMS, ENGINEERING PACKAGES, GRAPHICS PACKAGES, PROGRAMMING LANGUAGES, PROJECT MANAGEMENT PACKAGES, SCIENTIFIC SOFTWARE LIBRARIES AND CODES, STATISTICAL PACKAGES, SIMULATION/MODELING PACKAGES, P.C. COMMUNICATIONS PACKAGES, WORD PROCESSING PACKAGES, AND CAD/CAM AND FACTORY AUTOMATION PACKAGES.

Figure 2-2 shows a tabulation of the number of organizational level questionnaires, that indicated that a particular category of software was used or planned to be used on a particular level of hardware (i.e., mainframe, mini or micr). Figure 2-3 reduces that information into the number of organizations, out of the 25 that were surveyed, who need a particular category of software on a particular level of machine. Figure 2-4 shows the distribution of the organizations across the type of machine by the software package category. Figure 2-5 shows a distribution, of the software packages mentioned, organized by software package category across organizations.

An analysis of the data tabulated shows that: 100% (25/25) of the organizations surveyed need DATABASE MANAGEMENT CAPABILITIES; 64% (16/25) need ENGINEERING PACKAGES; 96% (24/25) need GRAPHICS CAPABILITIES; 88% (22/25) are interested in PROGRAMMING LANGUAGES; 88% (22/25) are interested in PROJECT MANAGEMENT PACKAGES; 52% (13/25) need SCIENTIFIC SOFTWARE LIBRARIES and CODES; 92% (23/25) need STATISTICAL PACKAGES; 60% (15/25) need SIMULATION/MODELING

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF THE NUMBER OF ORGANIZATIONAL LEVEL QUESTIONNAIRES
THAT INDICATED THE NEED FOR SOFTWARE IN A
PARTICULAR CATEGORY ON A PARTICULAR MACHINE TYPE

SOFTNUM	SOFTCAT	MACHTYPE	NUMBER OF ORGANIZATIONAL QUESTIONNAIRES
1	DATABASE MANAGEMENT	MAIN	30
		MICRO	51
		MINI	35
2	ENGINEERING PKGS	MAIN	10
		MICRO	13
		MINI	9
3	GRAPHICS	MAIN	29
		MICRO	48
		MINI	42
4	PROGRAMMING LANGUAGES	MAIN	31
		MICRO	45
		MINI	35
5	PROJECT MANAGEMENT	MAIN	15
		MICRO	35
		MINI	26
6	SCIENTIFIC SOFTWARE LIB	MAIN	17
		MICRO	13
		MINI	7
7	STATISTICAL	MAIN	16
		MICRO	21
		MINI	18
8	SIMULATION/MODELLING	MAIN	17
		MICRO	10
		MINI	10
9	PERSONAL COMPUTER COMM	MAIN	10
		MICRO	41
		MINI	15
10	WORD PROCESSING	MAIN	5
		MICRO	49
		MINI	22
11	CAD/CAM	MAIN	4
		MICRO	6
		MINI	6

Figure 2-2 Software Needs by Number of Organizational Respondents

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF THE NUMBER OF MICOM ORGANIZATIONS
THAT NEED A PARTICULAR CATEGORY OF SOFTWARE
ON MAINFRAMES, MICROS AND MINIS

SOFTNUM	SOFTCAT	MACHTYPE	NUMBER OF MICOM ORGANIZATIONS
1	DATABASE MANAGEMENT	MAIN	17
		MICRO	19
		MINI	20
2	ENGINEERING PKGS	MAIN	8
		MICRO	10
		MINI	8
3	GRAPHICS	MAIN	16
		MICRO	20
		MINI	21
4	PROGRAMMING LANGUAGES	MAIN	15
		MICRO	17
		MINI	18
5	PROJECT MANAGEMENT	MAIN	10
		MICRO	16
		MINI	16
6	SCIENTIFIC SOFTWARE LIB	MAIN	10
		MICRO	10
		MINI	6
7	STATISTICAL	MAIN	13
		MICRO	16
		MINI	15
8	SIMULATION/MODELLING	MAIN	12
		MICRO	7
		MINI	8
9	PERSONAL COMPUTER COMM	MAIN	7
		MICRO	19
		MINI	14
10	WORD PROCESSING	MAIN	4
		MICRO	19
		MINI	14
11	CAD/CAM	MAIN	4
		MICRO	5
		MINI	3

Figure 2-3 Software Needs by Number of Major MICOM Organizations

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF THE NUMBER OF MICOM ORGANIZATIONS
THAT NEED A PARTICULAR CATEGORY OF SOFTWARE
ON MAINFRAMES, MICROS AND MINIS

SOFTNUM	SOFTCAT / HEADORGCD	MACHTYPE MAIN	MICRO	MINI
1	DATABASE MANAGEMENT			
	AMCPM-ADCC	1	1	1
	AMCPM-AMWS	0	1	0
	AMCPM-ATM	0	1	1
	AMCPM-CF	0	1	1
	AMCPM-HA	1	1	1
	AMCPM-HD	0	1	1
	AMCPM-JM	1	1	1
	AMCPM-MD	1	1	1
	AMCPM-MP	1	0	1
	AMCPM-PE	1	1	1
	AMCPM-ROL	0	0	1
	AMCPM-RS	0	1	0
	AMCPM-TO	1	0	1
	AMSMI-D	0	1	1
	AMSMI-E	1	1	1
	AMSMI-F	1	1	1
	AMSMI-H	1	0	1
	AMSMI-JT	1	0	0
	AMSMI-Q	1	1	1
	AMSMI-R	1	1	1
	AMSMI-S	1	1	1
	AMSMI-U	0	1	1
	AMSMI-W	1	1	0
	AMSMI-Z	1	0	0
	AMXTM-X	1	1	1
*TOTAL SOFTNUM	1	17	19	20

Figure 2-4 Needs by Organization by Software Category Across Machines

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
CO NT OF THE NUMBER OF MICOM ORGANIZATIONS
THAT NEED A PARTICULAR CATEGORY OF SOFTWARE
ON MAINFRAMES, MICROS AND MINIS

SOFTNUM	SOFTCAT	MACHTYPE MAIN	MICRO	MINI
HEADORGCD				
2	ENGINEERING PKGS			
AMCPM-ADCC		0	1	1
AMCPM-ATM		0	1	1
AMCPM-CF		0	1	0
AMCPM-HA		0	1	0
AMCPM-HD		0	1	1
AMCPM-JM		1	0	0
AMCPM-MD		1	0	0
AMCPM-PE		1	0	0
AMCPM-TO		0	0	1
AMSMI-E		1	1	1
AMSMI-F		0	0	1
AMSMI-Q		1	1	0
AMSMI-R		1	1	1
AMSMI-S		1	1	1
AMSMI-W		1	0	0
AMXTM-X		0	1	0
*TOTAL SOFTNUM	2	8	10	8

Figure 2-4 Needs by Organization by Software Category Across Machines (cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF THE NUMBER OF MICOM ORGANIZATIONS
THAT NEED A PARTICULAR CATEGORY OF SOFTWARE
ON MAINFRAMES, MICROS AND MINIS

SOFTNUM	SOFTCAT	MACHTYPE MAIN	MICRO	MINI
HEADORGCD				
3	GRAPHICS			
AMCPM-ADCC		1	1	1
AMCPM-AMWS		0	1	0
AMCPM-ATM		0	1	1
AMCPM-CF		0	1	1
AMCPM-HA		1	1	1
AMCPM-HD		0	1	1
AMCPM-JM		1	1	1
AMCPM-MD		1	1	1
AMCPM-MP		1	1	1
AMCPM-PE		1	1	0
AMCPM-ROL		0	0	1
AMCPM-RS		1	1	1
AMCPM-TO		0	0	1
AMSMI-D		1	1	1
AMSMI-E		1	1	1
AMSMI-F		1	1	1
AMSMI-H		0	0	1
AMSMI-JT		1	0	0
AMSMI-Q		1	1	1
AMSMI-R		1	1	1
AMSMI-S		1	1	1
AMSMI-U		0	1	1
AMSMI-W		1	1	1
AMXTM-X		1	1	1
*TOTAL SOFTNUM	3	16	20	21

Figure 2-4 Needs by Organization by Software Category Across Machines (cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF THE NUMBER OF MICOM ORGANIZATIONS
THAT NEED A PARTICULAR CATEGORY OF SOFTWARE
ON MAINFRAMES, MICROS AND MINIS

SOFTNUM SOFTCAT / HEADORGCD	MACHTYPE MAIN	MICRO	MINI
4 PROGRAMMING LANGUAGES			
AMCPM-ADCC	1	1	1
AMCPM-AMWS	0	1	0
AMCPM-ATM	0	1	1
AMCPM-CF	0	1	1
AMCPM-HA	0	1	0
AMCPM-HD	0	1	1
AMCPM-JM	0	1	1
AMCPM-MD	1	1	1
AMCPM-MP	1	0	1
AMCPM-PE	1	1	0
AMCPM-ROL	1	0	1
AMCPM-RS	1	0	1
AMSMI-D	1	1	1
AMSMI-E	1	1	1
AMSMI-F	1	1	1
AMSMI-JT	1	0	0
AMSMI-Q	1	1	1
AMSMI-R	1	1	1
AMSMI-S	1	1	1
AMSMI-U	0	0	1
AMSMI-W	1	1	1
AMXTM-X	1	1	1
*TOTAL SOFTNUM 4	15	17	18

Figure 2-4 Needs by Organization by Software Category Across Machines (cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF THE NUMBER OF MICOM ORGANIZATIONS
THAT NEED A PARTICULAR CATEGORY OF SOFTWARE
ON MAINFRAMES, MICROS AND MINIS

SOFTNUM	SOFTCAT	MACHTYPE MAIN	MICRO	MINI
HEADORGCD				
5	PROJECT MANAGEMENT			
AMCPM-ADCC		1	1	1
AMCPM-AMWS		0	1	0
AMCPM-ATM		0	1	1
AMCPM-CF		0	1	1
AMCPM-HA		0	1	0
AMCPM-HD		0	1	1
AMCPM-JM		1	0	1
AMCPM-MD		1	0	1
AMCPM-MP		0	1	1
AMCPM-PE		1	1	0
AMCPM-RS		0	1	0
AMCPM-TO		0	0	1
AMSMI-D		1	1	1
AMSMI-E		1	1	1
AMSMI-F		0	1	1
AMSMI-JT		1	0	0
AMSMI-Q		1	1	1
AMSMI-R		0	1	1
AMSMI-S		1	1	1
AMSMI-U		0	0	1
AMSMI-W		1	0	0
AMXTM-X		0	1	1
*TOTAL SOFTNUM	5	10	16	16

Figure 2-4 Needs by Organization by Software Category Across Machines (cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF THE NUMBER OF MICOM ORGANIZATIONS
THAT NEED A PARTICULAR CATEGORY OF SOFTWARE
ON MAINFRAMES, MICROS AND MINIS

SOFTNUM SOFTCAT / HEADORGCD	MACHTYPE MAIN	MICRO	MINI
6 SCIENTIFIC SOFTWARE LIB			
AMCPM-ADCC	0	1	1
AMCPM-JM	1	1	0
AMCPM-MD	1	0	0
AMCPM-PE	1	1	0
AMCPM-ROL	1	0	0
AMCPM-RS	0	1	0
AMSMI-D	1	1	1
AMSMI-E	1	1	1
AMSMI-Q	1	1	0
AMSMI-R	1	1	1
AMSMI-S	1	1	1
AMSMI-W	1	1	0
AMXTM-X	0	0	1
*TOTAL SOFTNUM 6	10	10	6

Figure 2-4 Needs by Organization by Software Category Across Machines (cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF THE NUMBER OF MICOM ORGANIZATIONS
THAT NEED A PARTICULAR CATEGORY OF SOFTWARE
ON MAINFRAMES, MICROS AND MINIS

SOFTNUM	SOFTCAT	MACHTYPE MAIN	MICRO	MINI
HEADORGCD				
7	STATISTICAL			
AMCPM-ADCC		0	1	1
AMCPM-AMWS		0	1	0
AMCPM-ATM		0	1	1
AMCPM-CF		0	1	1
AMCPM-HA		0	1	0
AMCPM-HD		0	1	1
AMCPM-JM		1	1	1
AMCPM-MD		1	0	0
AMCPM-MP		0	0	1
AMCPM-PE		1	1	0
AMCPM-RS		1	0	1
AMCPM-TO		0	0	1
AMSMI-D		1	1	1
AMSMI-E		1	1	1
AMSMI-F		1	1	1
AMSMI-JT		1	0	0
AMSMI-Q		1	1	0
AMSMI-R		1	1	1
AMSMI-S		1	1	1
AMSMI-U		0	1	1
AMSMI-W		1	0	0
AMSMI-Z		1	0	0
AMXTM-X		0	1	1
*TOTAL SOFTNUM	7	13	16	15

Figure 2-4 Needs by Organization by Software Category Across Machines (cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF THE NUMBER OF MICOM ORGANIZATIONS
THAT NEED A PARTICULAR CATEGORY OF SOFTWARE
ON MAINFRAMES, MICROS AND MINIS

SOFTNUM	SOFTCAT	MACHTYPE MAIN	MICRO	MINI
HEADORGCD				
8	SIMULATION/MODELLING			
AMCPM-ADCC		1	1	1
AMCPM-HD		0	1	0
AMCPM-JM		1	1	1
AMCPM-MD		1	0	0
AMCPM-MP		0	0	1
AMCPM-PE		1	1	0
AMCPM-RS		1	0	0
AMSMI-D		1	0	1
AMSMI-E		1	1	1
AMSMI-JT		1	0	0
AMSMI-Q		1	1	1
AMSMI-R		1	0	0
AMSMI-S		1	1	1
AMSMI-U		0	0	1
AMSMI-W		1	0	0
*TOTAL SOFTNUM	8	12	7	8

Figure 2-4 Needs by Organization by Software Category Across Machines (cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF THE NUMBER OF MICOM ORGANIZATIONS
THAT NEED A PARTICULAR CATEGORY OF SOFTWARE
ON MAINFRAMES, MICROS AND MINIS

SOFTNUM	SOFTCAT	MACHTYPE MAIN	MICRO	MINI
HEADORGCD				
9	PERSONAL COMPUTER COMM			
AMCPM-ADCC		1	1	1
AMCPM-AMWS		0	1	0
AMCPM-ATM		0	1	1
AMCPM-CF		0	1	1
AMCPM-HA		0	1	0
AMCPM-HD		0	1	1
AMCPM-JM		0	1	0
AMCPM-MD		1	1	1
AMCPM-MP		0	0	1
AMCPM-PE		0	1	0
AMCPM-RS		1	1	1
AMSMI-D		1	1	1
AMSMI-E		0	1	1
AMSMI-F		1	1	1
AMSMI-Q		0	1	0
AMSMI-R		1	1	1
AMSMI-S		1	1	1
AMSMI-U		0	1	1
AMSMI-W		0	1	0
AMXTM-X		0	1	1
*TOTAL SOFTNUM	9	7	19	14

Figure 2-4 Needs by Organization by Software Category Across Machines (cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS

COUNT OF THE NUMBER OF MICOM ORGANIZATIONS
THAT NEED A PARTICULAR CATEGORY OF SOFTWARE
ON MAINFRAMES, MICROS AND MINIS

SOFTNUM SOFTCAT / HEADORGCD	MACHTYPE MAIN	MICRO	MINI
10 WORD PROCESSING			
AMCPM-ADCC	0	1	1
AMCPM-AMWS	0	1	0
AMCPM-ATM	0	1	1
AMCPM-CF	0	1	1
AMCPM-HA	0	1	0
AMCPM-HD	0	1	1
AMCPM-JM	0	1	0
AMCPM-MD	1	1	1
AMCPM-MP	0	1	1
AMCPM-PE	1	1	0
AMCPM-ROL	0	0	1
AMCPM-RS	0	1	0
AMCPM-TD	0	0	1
AMSMI-D	0	0	1
AMSMI-E	1	1	1
AMSMI-F	0	1	1
AMSMI-Q	0	1	0
AMSMI-R	0	1	1
AMSMI-S	1	1	1
AMSMI-U	0	1	1
AMSMI-W	0	1	0
AMXTM-X	0	1	0
*TOTAL SOFTNUM 10	4	19	14

Figure 2-4 Needs by Organization by Software Category Across Machines (cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF THE NUMBER OF MICOM ORGANIZATIONS
THAT NEED A PARTICULAR CATEGORY OF SOFTWARE
ON MAINFRAMES, MICROS AND MINIS

SOFTNUM SOFTCAT / HEADORGCD	MACHTYPE MAIN	MICRO	MINI
11 CAD/CAM			
AMCPM-ADCC	1	1	1
AMCPM-PE	1	1	0
AMSMI-E	0	1	1
AMSMI-R	1	1	1
AMSMI-S	0	1	0
AMSMI-W	1	0	0
*TOTAL SOFTNUM 11	4	5	3

Figure 2-4 Needs by Organization by Software Category Across Machines (cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF THE NUMBER OF MICOM ORGANIZATIONS
THAT NEED A PARTICULAR CATEGORY OF SOFTWARE
ON MAINFRAMES, MICROS AND MINIS

SOFTNUM SOFTCAT / HEADORGCD	MACHTYPE MAIN	MICRO	MINI
TOTAL	116	158	143

Figure 2-4 Needs by Organization by Software Category Across Machines (cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
TABULATION OF ORGANIZATIONS THAT USE OR NEED SOFTWARE PACKAGES
BY SOFTWARE CATEGORY BY SOFTWARE NAME ACROSS ORGANIZATIONS
HEADCD

SOFTWARE CATEGORY / SOFTWARE NAME	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
DATABASE MANAGEMENT																									
ADABAS								1											1						
CA-EXECUTIVE																			1						
DATACOM													1												
DBASE II/III	1	1	1				1	1			1		1	1			1	1	1			1	1		
INFO																					1				
PC/FOCUS			1																1						
PC/INQUIRE																			1						
SIR													1						1						
SYSTEM 2000			1		1	1			1	1			1				1		1			1	1	1	
TIS																			1						
TOTAL																			1						
LOTUS 123		1	1								1					1		1				1			
CONDOR			1											1											
RBASE 4000			1															1							
KNOWLEDGEMAN			1																			1			
HPDBMS			1																						
FRAMEWORK													1		1										
SYMPHONY											1		1					1							
TYPEMASTER											1														
MAPPER 1100																	1								
ARTIS																	1								
RIM6			1														1								
TDCMS																	1			1					
ILSMRS																	1								
IMAGE									1					1			1			1					1
DSREDS																	1								
INFORMIX						1								1								1			
UNIX														1											
MISTRESS						1									1							1			
TRACKS																							1		
CALMIS																							1		
ISAM																							1		
DIAP																		1							
PROFS																		1							
RAMIS II																		1							
TSOA																		1							
MULTIPLAN																						1	1		
PFSI FILE																						1			
PFSI REPORT																						1			
FILE-IT																						1			
MAIL-MERGE																						1			
IBM 3275 EMULATOR																	1								

LEGEND FOR HEADCD:

1.ADV MP WPN SYS PROJ OFC	2.AIR DEF COM/CON PROJ OFC	3.ARMY MISS LAB	4.CHAP/FAAR PROJ OFC	5.CIV OFC TNG MGT DIV
6.CMPT	7.HAWK PROJ OFC	8.HELLFIRE/GLD PROJ OFC	9.INT LOG SUPP OFC	10.INTMAT LOG DIR
11.JNT ATAC MISS PROJ OFC	12.JTACMS PROJ OFC	13.MGT INFO SYST DIR	14.MISS LOG CNTR	15.MISS SYS READ DIR
16.MLRS PROJ OFC	17.PATRIOT PROJ OFC	18.PERSHING PROJ OFC	19.PROD ASSUR DIR	20.STINGER PROJ OFC
21.SYST ANAL EVAL OFC	22.SYS-ENG PROD DIR	23.TMDE SUPP GR	24.TOW PROJ OFC	25.US ROLAND PROJ OFC

Figure 2-5 Software Packages Required or Used by Organizations

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
TABULATION OF ORGANIZATIONS THAT USE OR NEED SOFTWARE PACKAGES
BY SOFTWARE CATEGORY BY SOFTWARE NAME ACROSS ORGANIZATIONS
HEADCD

SOFTWARE CATEGORY / SOFTWARE NAME	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
DATABASE MANAGEMENT																									
MANUFACTURER SUPPLIE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
USER GENERATED	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
UNKNOWN PACKAGE	.	1	1	1	.	1	1	1	.	.	1	1	.	.	1	1	1	.	.	1	.	.	1	1	.
*TOTAL SOFTCAT DATABASE MANAGEMENT	1	3	10	1	1	5	2	3	2	1	5	1	6	5	3	2	11	10	9	3	1	11	7	2	2
ENGINEERING PKGS																									
ABAQUS	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
ECAP	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
FLUSH	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
NASTRAN 17.5	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
SAP	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
SHAKE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
STRESS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
LOTUS 123	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SYMPHONY	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TK SOLVER	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
IMSL	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
ELECTRONIC CIRCUIT A	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
TEX GAP 2D	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TEX GAP 3D	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
FINITE ELEMENT	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CONTRACTOR GENERATED	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
UNKNOWN PACKAGE	.	1	.	1	.	.	1	1	.	.	1	1	.	.	.	.	1	.	.	.	.	1	1	1	.
*TOTAL SOFTCAT ENGINEERING PKGS	0	2	4	1	0	1	1	1	0	0	4	1	3	1	0	0	1	3	1	0	0	3	1	1	0
GRAPHICS																									
CALCOMP	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.
DISSPLA	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	1	.	1	.	.	1	.	.	.
IMSL PLOTS	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.
INTERACTIVE DATA DIS	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	.	.	.
SCIENTIFIC SUBROUTIN	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
TEKTRONIX PLOT10	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	1	1	1	1	1	1	.	.	.
TEKTRONIX AGL1B	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	1	.	1	.	.	.	.
SYMAP	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
ENERGRAPHICS	.	.	.	.	.	1	.	1	.	.	1	.	.	.	.	1	.	.	1	.	.	1	.	.	.
LISADRAW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
GRAPHHOPPER	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
SINEMASTER	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

LEGEND FOR HEADCD:

1.ADV MP WPN SYS PROJ OFC	2.AIR DEF COM/CON PROJ OFC	3.ARMY MISS LAB	4.CHAP/FAAR PROJ OFC	5.CIV OFC TNG MGT DIV
6.CMPT	7.HAWK PROJ OFC	8.HELLFIRE/GLD PROJ OFC	9.INT LOG SUPP OFC	10.INTMAT LOG DIR
11.JNT ATAC MISS PROJ OFC	12.JTACMS PROJ OFC	13.MGT INFO SYST DIR	14.MISS LOG CNTR	15.MISS SYS READ DIR
16.MLRS PROJ OFC	17.PATRIOT PROJ OFC	18.PERSHING PROJ OFC	19.PROD ASSUR DIR	20.STINGER PROJ OFC
21.SYST ANAL EVAL OFC	22.SYS-ENG PROD DIR	23.TMDE SUPP GR	24.TOW PROJ OFC	25.US ROLAND PROJ OFC

Figure 2-5 Software Packages Required or Used by Organizations (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
TABULATION OF ORGANIZATIONS THAT USE OR NEED SOFTWARE PACKAGES
BY SOFTWARE CATEGORY BY SOFTWARE NAME ACROSS ORGANIZATIONS
HEADCD

SOFTWARE CATEGORY / SOFTWARE NAME	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
GRAPHICS																									
GRAPHAMATIC	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CHARTMASTER	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SYMPHONY	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TK SOLVER	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MAPPER 1100	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
TELL-A-GRAM	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
PACIFIC BASIN	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
TELEGRAPH	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
DRGRAPH	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
LOTUS 123	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.
PFS GRAPH	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
SOFTGRAPH	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
PAINTBRUSH	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
AUTOPLOT	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MICRO SOFTCHART	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
INTERGRAPHICS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
VISIPLOT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
PACIFIC BASIN GRAPHI	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
HP CHARTS & TEXT PRO	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	.	.	.	.	.
ISSCO	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
TELLAPLAN	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
GRAFWRITER	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
GRAFIT	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MANUFACTURER SUPPLIE	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
CONTRACTOR GENERATED	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.
UNKNOWN PACKAGE	1	1	1	1	.	1	1	1	.	.	1	1	1	1	1	.	1	.	.	1	.	1	1	1	1
*TOTAL SOFTCAT GRAPHICS	2	5	10	4	1	6	2	3	1	0	5	1	5	1	1	3	6	4	11	5	3	12	4	1	1
PROGRAMMING LANGUAGES																									
ADA	.	1	1	.	1	.	1	.	.	.	1	1	1	.	1	.	.	1	1	.	1	1	1	.	.
ALGOL	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.
APL	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	1	.	.	.
ASSEMBLER	.	1	1	1	.	.	.	.	.	.	.	.	1	.	.	.	1	1	1	.	1	1	.	.	.
BASIC	1	1	1	1	.	1	1	1	.	.	1	1	1	1	1	.	1	1	1	1	1	1	1	.	1
BLISS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
C	1	1	1	.	.	1	1	1	.	.	.	.	1	1	1	.	.	.	1	.	1	1	1	.	.
COBOL	1	1	.	1	1	.	.	.	.	.	.	.	1	.	.	.	1	1	1	.	1	1	1	.	.
CORAL-66	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
FORTRAN	1	1	1	1	1	1	.	1	.	.	1	.	1	1	1	1	1	1	1	.	1	1	1	.	1
LISP	.	1	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	1	.	.	.

LEGEND FOR HEADCD:

1.ADV MP WPN SYS PROJ OFC	2.AIR DEF COM/CON PROJ OFC	3.ARMY MISS LAB	4.CHAP/FAAR PROJ OFC	5.CIV OFC TNG MGT DIV
6.CMPT	7.HAWK PROJ OFC	8.HELLFIRE/GLD PROJ OFC	9.INT LOG SUPP OFC	10.INTNAT LOG DIR
11.JNT ATAC MISS PROJ OFC	12.JTACMS PROJ OFC	13.MGT INFO SYST DIR	14.MISS LOG CNTR	15.MISS SYS READ DIR
16.MLRS PROJ OFC	17.PATRIOT PROJ OFC	18.PERSHING PROJ OFC	19.PROD ASSUR DIR	20.STINGER PROJ OFC
21.SYST ANAL EVAL OFC	22.SYS-ENG PROD DIR	23.TMDE SUPP GR	24.TOW PROJ OFC	25.US ROLAND PROJ OFC

Figure 2-5 Software Packages Required or Used by Organizations (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
TABULATION OF ORGANIZATIONS THAT USE OR NEED SOFTWARE PACKAGES
BY SOFTWARE CATEGORY BY SOFTWARE NAME ACROSS ORGANIZATIONS

SOFTWARE CATEGORY / SOFTWARE NAME	HEADCD 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
PROGRAMMING LANGUAGES																									
PASCAL	1	1	1	.	1	.	.	1	.	.	1	.	1	1	.	.	.	1	1	.	1	1	1	.	.
PL/1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	1	.	.	.
SNOBOL	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.
TURBO PASCAL	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
COMO	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
UNIXSHELL	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
DBV COMPILER	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
DB(DEBUGGER)	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
MORTIN UTILITIES	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
DISK MECHANIC	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
PC TITLE	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
SUPER KEY	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
MACHINE LANGUAGE	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ANY PACKAGE	.	1	.	1	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.
*TOTAL SOFTCAT PROGRAMMING LANGUAGES	5	10	8	5	6	4	3	5	0	0	5	2	9	11	4	1	5	8	13	2	8	11	6	0	2
PROJECT MANAGEMENT																									
VISION	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
TRACE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
HARVARD-PM	1	1	1	.	.	.	.	1	.	.	1	.	.	1	.	.	.	1	.	.	.	1	.	.	.
PERTMASTER	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.
MICRO PERT	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
PROJECT CONTROL PROG	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	
PROJECT PLANNER	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	1	.	.	
PROJECT MASTER	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
MILESTONE	.	1	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	1	.	1	.	.	.
ARTEMIS	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	1	.	1	1	1	.	.	.
PERT MASTER-1500	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
OPTIMA1100	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
PROJECT2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
PERT	1	.	1	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.
PICE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
PILSHR	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
MULTIPLAN	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.
TOTAL PROJECT MANAGE	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SYMPHONY	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
UNKNOWN PACKAGE	.	1	1	1	.	1	1	1	.	.	1	1	.	1	1	.	1	.	.	1	.	1	1	1	.
*TOTAL SOFTCAT PROJECT MANAGEMENT	2	6	5	2	1	1	1	3	0	0	3	2	1	3	1	1	4	5	5	5	1	8	2	1	0

LEGEND FOR HEADCD:

1.ADV MP WPN SYS PROJ OFC	2.AIR DEF COM/CON PROJ OFC	3.ARMY MISS LAB	4.CHAP/FAAR PROJ OFC	5.CIV OFC TMG MGT DIV
6.CMPT	7.HAWK PROJ OFC	8.HELLFIRE/GLD PROJ OFC	9.INT LOG SUPP OFC	10.INTMAT LOG DIR
11.JNT ATAC MISS PROJ OFC	12.JTACMS PROJ OFC	13.MGT INFO SYST DIR	14.MISS LOG CNTR	15.MISS SYS READ DIR
16.MLRS PROJ OFC	17.PATRIOT PROJ OFC	18.PERSHING PROJ OFC	19.PROD ASSUR DIR	20.STINGER PROJ OFC
21.SYST ANAL EVAL OFC	22.SYS-ENG PROD DIR	23.TMDE SUPP GR	24.TOW PROJ OFC	25.US ROLAND PROJ OFC

Figure 2-5 Software Packages Required or Used by Organizations (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
TABULATION OF ORGANIZATIONS THAT USE OR NEED SOFTWARE PACKAGES
BY SOFTWARE CATEGORY BY SOFTWARE NAME ACROSS ORGANIZATIONS
HEADCD

SOFTWARE CATEGORY / SOFTWARE NAME	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
SCIENTIFIC SOFTWARE LIB																									
ARGONNE LABS (EISPAC	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
AEROSPACE RESEARCH L	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.
IMSL	.	.	1	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	1	.	.	.	.	.	.
CDC MATH SCIENCE LIB	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	1	.	1	1	.	.	.
SANDIA LABS (DIFFERE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.
NTH MATH-STAT	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.	.	.
NUMERICAL ALGORITHMS	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	1	.	.	.
SCIENTIFIC SUBROUTIN	.	1	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	1	.	1	1	.	.	.
ISFUG	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
MISD LIBRARY	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ADA LIBRARY	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
FORTRAN LIBRARY	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PASCAL LIBRARY	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ALT LIBRARY	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
CONTRACTOR GENERATED	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
USER GENERATED	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
UNKNOWN PACKAGE	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.
*TOTAL SOFTCAT SCIENTIFIC SOFTWARE LIB	0	4	10	0	0	0	0	0	0	0	1	5	1	0	2	1	4	5	0	4	7	1	0	1	
STATISTICAL																									
NTH MATH-STAT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.	.	.	.
OMNITAB	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
SAS	.	.	.	.	1	.	.	.	.	1	.	.	1	1	.	.	.	1	.	1	1	1	.	.	.
SPSS	.	1	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.
SIR	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
LOTUS 123	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SYMPHONY	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TK SOLVER	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MULTIPLAN	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TRADE OFF ANALISIS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
REGRESSION ANAL.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
PROJECTORIES	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
SUBROUTINE LIB.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MATH SCIENCE LIB.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
CONTRACTOR GENERATED	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
USER GENERATED	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
UNKNOWN PACKAGE	1	1	1	1	.	1	1	1	.	.	1	1	.	.	1	1	.	1	.	.	.	1	1	1	.
*TOTAL SOFTCAT STATISTICAL	1	3	3	1	1	2	1	1	0	1	4	1	4	1	2	1	1	1	2	2	3	4	2	1	0

LEGEND FOR HEADCD:

1.ADV MP WPN SYS PROJ OFC	2.AIR DEF COM/CON PROJ OFC	3.ARMY MISS LAB	4.CHAP/FAAR PROJ OFC	5.CIV OFC TMG MGT DIV
6.CMPT	7.HAWK PROJ OFC	8.HELLFIRE/GLD PROJ OFC	9.INT LOG SUPP OFC	10.INTMAT LOG DIR
11.JNT ATAC MISS PROJ OFC	12.JTACMS PROJ OFC	13.MGT INFO SYST DIR	14.MISS LOG CNTR	15.MISS SYS READ DIR
16.MLRS PROJ OFC	17.PATRIOT PROJ OFC	18.PERSHING PROJ OFC	19.PROD ASSUR DIR	20.STINGER PROJ OFC
21.SYST ANAL EVAL OFC	22.SYS-ENG PROD DIR	23.TMDE SUPP GR	24.TOW PROJ OFC	25.US ROLAND PROJ OFC

Fiugre 2-5 Software Packages Required or Used by Organizations (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
TABULATION OF ORGANIZATIONS THAT USE OR NEED SOFTWARE PACKAGES
BY SOFTWARE CATEGORY BY SOFTWARE NAME ACROSS ORGANIZATIONS
HEADCD

SOFTWARE CATEGORY / SOFTWARE NAME	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
SIMULATION/MODELLING																									
CSMP - CONTINUOUS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.
DYNAMO - CONTINUOUS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
GASP BOTH	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.
GPSS - DISCRETE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
MIMIC - CONTINUOUS	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	1	.	.	.
SIMSCRIPT - DISCRETE	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.
ACSL	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.
SLAM	.	.	1	.	1	.	.	.	.	.	.	1	1	1	.	.	.	1	1	.	1	1	.	.	.
COMMO	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SLAM II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
MIDAS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
MCATO	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
UNKNOWN PACKAGE	.	.	.	.	.	.	.	1	.	.	.	1	.	.	1	1	.	.	.	1	.	.	.	.	.
*TOTAL SOFTCAT SIMULATION/MODELLING	0	3	2	0	1	0	0	1	0	0	0	2	5	1	1	1	1	2	2	1	1	10	0	0	0
PERSONAL COMPUTER COMM																									
ACCESS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
CROSSTALK	1	1	1	.	.	1	.	.	.	.	1	.	1	1	.	.	.	1	1	.	.	1	.	.	.
DATA CAPTURE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
INTELLITERM	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.
MICRO LINK II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
MTERM	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
OMNITERM 2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
PC-TALK II	1	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PERFECT TALK	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
PERSONAL COMMUNICATI	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
SMARTCOM II	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.
SMARTERM 100	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.
THE IMPERSONATOR	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SMARTCOM	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
IPC	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CONFER II	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
FRAMEWORK	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SYMPHONY	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TSOA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
PROFS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
ACSII EXPRESS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
MU-200	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MANUFACTURER SUPPLIE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
CONTRACTOR GENERATED	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.

LEGEND FOR HEADCD:

1.ADV MP WPN SYS PROJ OFC	2.AIR DEF COM/CON PROJ OFC	3.ARMY MISS LAB	4.CHAP/FAAR PROJ OFC	5.CIV OFC TNG MGT DIV
6.CMPT	7.HAWK PROJ OFC	8.HELLFIRE/GLD PROJ OFC	9.INT LOG SUPP OFC	10.INTMAT LOG DIR
11.JNT ATAC MISS PROJ OFC	12.JTACMS PROJ OFC	13.MGT INFO SYST DIR	14.MISS LOG CNTR	15.MISS SYS READ DIR
16.MLRS PROJ OFC	17.PATRIOT PROJ OFC	18.PERSHING PROJ OFC	19.PROD ASSUR DIR	20.STINGER PROJ OFC
21.SYST ANAL EVAL OFC	22.SYS-ENG PROD DIR	23.TMDE SUPP GR	24.TOW PROJ OFC	25.US ROLAND PROJ OFC

Figure 2-5 Software Packages Required or Used by Organizations (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
TABULATION OF ORGANIZATIONS THAT USE OR NEED SOFTWARE PACKAGES
BY SOFTWARE CATEGORY BY SOFTWARE NAME ACROSS ORGANIZATIONS

SOFTWARE CATEGORY / SOFTWARE NAME	HEADCD 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
PERSONAL COMPUTER COMM																									
USER GENERATED	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
UNKNOWN PACKAGE	.	i	i	i	.	i	i	i	.	.	i	i	.	i	i	i	i	.	.	i	i	.	i	.	.
*TOTAL SOFTCAT PERSONAL COMPUTER COMM	2	4	4	1	0	3	2	3	0	0	4	1	1	3	1	1	3	6	6	1	1	7	1	0	0
WORD PROCESSING																									
MULTIMATE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
CPT	.	1	1	.	.	1	1	.	.	.	1	.	.	1	.	1	.	.	.	.	.	.	.	.	.
BONNIE BLUE	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
WORDSTAR	.	1	1	1	.	1	.	1	.	.	1	.	1	1	.	.	1	1	.	1	.	1	.	.	.
RUNOFF	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
EASYWRITER	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
NATIVE	.	.	.	.	.	.	1	.	.	.	.	1	.	.	1	.	.	.	.	1	.	.	.	.	.
TYPEMASTER	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MENUMAKER	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
LEXITRON	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
MASE	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
XENIX	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MATH PAK	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
DISHORT	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SPELLCHECK	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PERFECTWRITER	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
UNIX	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SPREAD SHEET	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
WRITE ONE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
VTAM PROFS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
VELN WRITER	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
SPELLSTAR	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
PFS WRITE	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
OPUS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	1	.	.	.
DICTIONARY	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
WORD/100	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
SYMPHONY	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
FRAMEWORD	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MAPPER	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
DEC MATE 3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
MCWRITE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
IWORD	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
PTP-100	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
MANUFACTURER SUPPLIE	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
USER GENERATED	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1

LEGEND FOR HEADCD:

1.ADV MP WPN SYS PROJ OFC	2.AIR DEF COM/CON PROJ OFC	3.ARMY MISS LAB	4.CHAP/FAAR PROJ OFC	5.CIV OFC TNG MGT DIV
6.CMPT	7.HAWK PROJ OFC	8.HELLFIRE/GLD PROJ OFC	9.INT LOG SUPP OFC	10.INTMAT LOG DIR
11.INT ATAC MISS PROJ OFC	12.JTACMS PROJ OFC	13.MGT INFO SYST DIR	14.MISS LOG CNTR	15.MISS SYS READ DIR
16.MLRS PROJ OFC	17.PATRIOT PROJ OFC	18.PERSHING PROJ OFC	19.PROD ASSUR DIR	20.STINGER PROJ OFC
21.SYST ANAL EVAL OFC	22.SYS-ENG PROD DIR	23.TNDE SUPP GR	24.TOW PROJ OFC	25.US ROLAND PROJ OFC

Figure 2-5 Software Packages Required or Used by Organizations (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
TABULATION OF ORGANIZATIONS THAT USE OR NEED SOFTWARE PACKAGES
BY SOFTWARE CATEGORY BY SOFTWARE NAME ACROSS ORGANIZATIONS
HEADCD

SOFTWARE CATEGORY / SOFTWARE NAME	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
WORD PROCESSING																									
UNKNOWN PACKAGE	1	1	.	1	.	1	1	1	.	.	1	.	.	1	1	.	.	1	.	1	.	1	1	1	.
*TOTAL SOFTCAT WORD PROCESSING	1	4	8	2	0	7	3	7	0	0	4	1	1	4	3	2	4	7	2	4	1	6	4	1	1
CAD/CAM																									
APT IV	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
UNASS	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ICAM	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
AUTOTROL	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
AUTOCAD	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.
NCATO	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
CAD	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
UNKNOWN PACKAGE	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.
*TOTAL SOFTCAT CAD/CAM	0	3	2	0	0	0	0	0	0	0	0	0	1	1	0	0	0	2	0	0	0	3	0	0	0
TOTAL	14	47	66	17	11	29	15	27	3	2	34	13	41	32	16	14	37	52	56	23	23	82	28	7	7

LEGEND FOR HEADCD:

1.ADV MP WPN SYS PROJ OFC	2.AIR DEF COM/CON PROJ OFC	3.ARMY MISS LAB	4.CHAP/FAAR PROJ OFC	5.CIV OFC TNG MGT DIV
6.CMPT	7.HAWK PROJ OFC	8.HELLFIRE/GLD PROJ OFC	9.INT LOG SUPP OFC	10.INTMAT LOG DIR
11.JNT ATAC MISS PROJ OFC	12.JTACMS PROJ OFC	13.MGT INFO SYST DIR	14.MISS LOG CNTR	15.MISS SYS READ DIR
16.MLRS PROJ OFC	17.PATRIOT PROJ OFC	18.PERSHING PROJ OFC	19.PROD ASSUR DIR	20.STINGER PROJ OFC
21.SYST ANAL EVAL OFC	22.SYS-ENG PROD DIR	23.TMDE SUPP GR	24.TOW PROJ OFC	25.US ROLAND PROJ OFC

Figure 2-5 Software Packages Required or Used by Organizations (Cont'd)

PACKAGES; 80% (20/25) need PERSONAL COMPUTER COMMUNICATIONS PACKAGES; 88% (22/25) need WORD PROCESSING PACKAGES; and 24% (6/25) need CAD/CAM and FACTORY AUTOMATION PACKAGES. The data shows that the demand for software packages is relatively high at all levels of hardware.

The Scientific and Engineering User Community desires software packages, programming languages and operating systems that operate across levels of Vendor's hardware and that operate across different Vendor's machines. They also want total support for these software capabilities across all computer hardware used on the Arsenal.

The conclusion of the computer software analysis is that a full and comprehensive study needs to be initiated to seek out, acquire, test and demonstrate useful software packages that meet the User's Requirements. Unfortunately, this type of effort was beyond the scope of this contract.

The Users feel that the support for software packages provided on the Arsenal is inadequate for their needs, as far as: availability of services to acquire, install, operate, and maintain software packages; services to provide consultation, training and End-User Application development using software packages; and hot-line problem solving support areas, are concerned. TOTAL TURNKEY SUPPORT of software packages is required.

2.1.3 Current Telecommunications Hardware Capabilities

The data collected during the survey showed that the S&E Community is supported by only 184 Modems, 12 Multiplexors, 5 Communications Processors and 235 Communications lines/circuits. The S&E Center currently provides telecommunications access through a CDC Network Processing Unit; through which, asynchronous and synchronous devices can communicate with the

central computers. Both dedicated and dial-up service is provided at various speeds. Dedicated lines are provided at 2400 and 4800 BAUD. Dial-up access is permitted at 300, 1200, 2000 and 4800 BAUD. Approximately 33 dedicated and 30 dial-up circuits belonging to the S&E Central Computing Facility are currently in use by the User Community. Remote Job Entry services are predominantly provided at 4800 BAUD. The entire S&E Community is supported by only the basic methods of communications, point-to-point dedicated and dial-up service. In the future, substantially greater demands for communications service will develop in the graphics and CAD/CAM areas. Careful network planning, design, implementation and support will become a very important line of business for IMD.

Most, if not all of the telecommunications equipment used to support the S&E Community is very old and obsolete. The maintenance costs are relatively high and the capability is mediocre. Basically, a detailed telecommunications networking requirements analysis should be initiated, so that a broadband local area network can be designed to meet the telecommunications requirements of the S&E Users.

In the meantime, the replacement of old modems and acquisition of new modems and switches would benefit the S&E User Community. For example, Users with terminals hard-wired to a Hewlett-Packard machine cannot use the same terminals to hook up to the CDC machine, even if they wanted to, because they don't have modems and "T" switches necessary to make their terminals more useful. IMD should provide new modems and "T" switches to the User Community as a means of showing that IMD is interested in satisfying the User's needs. In addition, an upgrading of the RJE service from 4800 to 9600 BAUD might be welcome by some of the larger S&E User groups.

At the Central Facility, the existing individual modems should be replaced with modern modem cabinets and modem cards. This action will save both a lot of space and cut down on maintenance and electricity costs. The use of some multi-drop circuits in the future can be used to connect more terminals to the same number of communications ports.

The study revealed that many organizations are planning to implement their "own" local area networks. This seemingly uncoordinated proliferation of local area networks, will probably create many telecommunications headaches for the Command. IMD must take steps to standardize the network transport protocols, to ensure compatibility between local area networks on the Arsenal. A concept that should be pursued is the design and implementation of an Integrated Data Communications Utility Network based upon the X.25 Protocol. But first, a detailed Networking Requirements analysis should be performed to obtain some system sizing information. This will ensure that a good initial design can be performed as the next step towards implementation of the Network which will satisfy the S&E User's needs.

2.1.4 Current Telecommunications Software Analysis

The S&E Community is supported by a wide variety of telecommunications software capabilities. This is partially due to the variety of computer, peripheral device and scientific instrumentation Vendors that are used throughout the Arsenal; and partially due to the variety of Personal Computer Communications Software packages, that are available for the minicomputers and microcomputers, that are used on the Arsenal. Basically, the capabilities fall into five broad categories: Real-Time, Interactive, Remote Job Entry (Batch), Networking and Personal Computer Communications. The Real-Time telecommunications software is used for Real-Time Simulation, Modeling, Data Acquisition and Data Reduction Applications. Real-Time communications is the fastest method of data transmission. Interactive telecommunications software allows Users to hook-up directly to the Host Computer. And, using various type of terminals with keyboards, the Users can perform their general purpose S&E Applications work. The Remote Job Entry (RJE) software allows transmission of Batch Jobs, Data Files, Printouts, etc., from computer to computer, or, from a host computer to a remote printing work station. Networking software is used to provide data transmission services from the End-Users to any computer or device that is on a Network of computers and devices. Networking techniques include both broad-band and base-band, local and wide-area telecommunications concepts. Personal Computer Communications software provides file transfer capabilities from Personal Computer to Personal Computer, and some file transfer capability between the microcomputer and a Host computer.

The mainframes, large minicomputers and microcomputers support CDC UT200, HASP Multi-Leaving, 2780/3780, 3270 BSC, SDLC, HDLC, ETHERNET, OPENNET, X.25, UNISCOPE and a variety of other vendor unique communication technologies.

Networking support exists or will be required for: CDCNET, IBMSNA, DECNET, HP ADVANCENET, SPERRYLINK and other vendor's networking software systems. An independent packet-switched Data Communications Utility network can have network gateways to all of the vendors unique technologies. A more detailed analysis of the networking software area was beyond the scope of this contract.

At the Personal Computer level, some interesting data was collected on the subject of P.C. Communications. The data showed that 80% (20/25) of the MICOM organizations need P.C. Communications support. Figure 2-4 shows the organizations that are interested in P.C. Communications. Figure 2-6 shows a tabulation of the responses received regarding the current and future use of P.C. Communications software packages. Figure 2-6 indicates: the software package; whether or not the package is used now; whether or not it will be used in the future; the level of importance associated with the communications software package; and, the number of respondents that indicated a particular combination of comments regarding a specific package.

An analysis of the information contained in Figure 2-6, shows that CROSSTALK is the most popular P.C. Communications package and that many sub-organizations and organizations consider P.C. Communications to be "VERY IMPORTANT" to them and their work environments. It also shows that 38 out of 107 respondents indicated that they need help in selecting a P.C. Communications software package to satisfy their needs. Right now, this type of consulting support on software packages in general, is not readily available from IMD. Figure 2-7 shows the emerging interest in P.C. Communications software capabilities that exists across the survey respondents.

In conclusion, the telecommunications software requirements are only beginning to surface at MICOM. A great deal of planning and design work needs to take place; and, some decisions need to be made regarding the standardization of telecommunications support and networking at MICOM. The telecommunications requirements at MICOM will mushroom over the next ten years. Without careful planning, design, operation, maintenance and support of a standard communications capability, the communication needs of the S&E Community will not be met in a smooth and cost-effective manner.

SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
TABULATION OF CURRENT AND FUTURE USE OF P.C. COMMUNICATIONS SOFTWARE PACKAGES
BY SOFTWARE PACKAGE AND ACROSS LEVEL OF IMPORTANCE

SOFTWARE PACKAGE NAME	USE_NOW	FUTURE_USE	LEVEL OF IMPORTANCE 1	2	3
ACCESS	NO	YES	2	0	0
ACSII EXPRESS	NO	YES	2	0	0
CONFER II	YES	YES	0	2	0
CONTRACTOR GENERATED	YES	YES	1	0	0
CROSSTALK	NO	YES	10	2	2
	YES	YES	8	1	1
DATA CAPTURE	NO	YES	3	0	0
FRAMEWORK	YES	YES	1	0	0
INTELLITERM	NO	YES	1	1	0
IPC	NO	YES	1	0	0
MANUFACTURER SUPPLIED	YES	YES	1	0	0
MICRO LINK II	NO	YES	0	1	0
MTERM	NO	YES	3	0	0
MU-200	YES	YES	1	0	0
OMNITERM 2	NO	YES	0	0	1
PC-TALK II	NO	YES	1	0	2
	YES	YES	2	0	1
PERFECT TALK	YES	YES	1	0	0
PERSONAL COMMUNICATIONS MANAGER	NO	YES	0	1	0
PROFS	YES	YES	1	0	0
SMARTCOM	NO	YES	0	2	0
	YES	YES	0	1	0
SMARTCOM II	YES	YES	2	1	0
SMARTEM 100	NO	YES	3	1	0

LEGEND: 1. VERY IMPORTANT 3. MARGINALLY IMPORTANT
2. IMPORTANT 4. NOT IMPORTANT

Figure 2-6 P.C. Communications Software Package Interest

SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
TABULATION OF CURRENT AND FUTURE USE OF P.C. COMMUNICATIONS SOFTWARE PACKAGES
BY SOFTWARE PACKAGE AND ACROSS LEVEL OF IMPORTANCE

SOFTWARE PACKAGE NAME	USE_NOW	FUTURE_USE	LEVEL OF IMPORTANCE 1	2	3
SYMPHONY	YES	YES	1	0	0
THE IMPERSONATOR	NO	YES	1	0	0
TSOA	YES	YES	1	0	0
UNKNOWN PACKAGE	NO	YES	35	2	1
	YES	YES	7	0	0
USER GENERATED	NO	YES	0	1	0
	YES	YES	2	2	0
TOTAL			91	18	8

LEGEND: 1. VERY IMPORTANT 3. MARGINALLY IMPORTANT
2. IMPORTANT 4. NOT IMPORTANT

Figure 2-6 P.C. Communications Software Package Interest (Contd.)

SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
TABULATION OF CURRENT AND FUTURE USE OF P.C. COMMUNICATIONS SOFTWARE PACKAGES
ACROSS LEVEL OF IMPORTANCE

		LEVEL OF IMPORTANCE			
	USE NOW FUTURE USE	1	2	3	TOTAL
	NO YES	62	11	6	79
	YES YES	29	7	2	38
TOTAL		91	18	8	117

LEGEND: 1. VERY IMPORTANT 3. MARGINALLY IMPORTANT
2. IMPORTANT 4. NOT IMPORTANT

Figure 2-7 Aggregate Interest in P.C. Communications Software Packages

2.1.5 Current Terminal Support Analysis

The S&E Community utilizes a variety of terminals provided by about 50 different hardware vendors. The types of terminals used range from very simple portable TTY terminals, to dumb CRT terminals, to intelligent CRT terminals, to simple and complicated graphics and color graphics terminals, to complete Remote Job Entry terminal configurations, and through sophisticated microprocessor controlled clustered terminal workstation configurations. Many of the more complicated configurations have attached printer and plotter capabilities.

The DARCOM ADPE Inventory Report contained 1405 pieces of equipment that we classified into the category of "TERMINALS". Sufficient time was not available to properly research all vendor's make and model numbers, nor was it required by the contract. But, nevertheless, the classification process was reasonably accurate. Figure 2-8 provides a tabulation of the number of terminal configurations by Vendor and Model, along with an aggregation of the purchase price, monthly maintenance and rental costs. It shows that MICOM has about 3.2 million dollars invested in terminal configurations. Figure 2-9 shows the growth pattern of equipment in the terminal category by calendar year. Some of the terminals in the inventory may no longer be in service; but, it can readily be seen from Figure 2-9, that the demand for terminals has been steadily growing over the last ten years and is likely to increase in the future. It also can be observed that over 40% of the terminal equipment is over five years old. Most of the older terminals should be replaced during the next two years.

The data collected from the survey showed that, by the end of FY 85, approximately 437 additional terminals would exist on the Arsenal; and, that

over the next ten years, approximately 242 more terminals would be required. But, with the advent of the Intel purchase, terminals can be easily acquired; and, probably, the number acquired will be much greater than the number indicated by the survey respondents. The total maximum demand for terminals for the S&E Community is estimated at 1500 terminals. Many of the terminals in use by the S&E Community are in need of replacement with terminal configurations that are suitable for S&E work.

In conclusion, the number of S&E Computing Users will increase dramatically over the next ten years; and, so will the demand for terminal configurations upon which the End-Users can get their work done. A more detailed analysis of the End-User work environments should be made in an effort to determine the actual End-User terminal/work area equipment requirements. This type of study could then be used as input to procure sufficient amounts of the required equipment for the S&E User Community on a turnkey basis. This could be performed by IMD as a service to the S&E Community. This turnkey process could further be used as a tool towards standardization of the terminal population on the Arsenal by facilitating procurement for the End-Users.

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF TERMINALS AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF TERMINALS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
AAE	1	2	500	0	0
*TOTAL AAE		2	500	0	0
ADD	100	1	2,000	0	0
	REG	1	1	0	0
*TOTAL ADD		2	2,001	0	0
AJI	832	1	4,120	0	0
*TOTAL AJI		1	4,120	0	0
CDC	18	1	14,539	146	0
	217	13	99,888	871	0
	628	1	1	0	0
	6612	1	27,668	193	0
	742	1	415	16	0
	9766	1	15,000	0	0
*TOTAL CDC		18	157,511	1,226	0
CIH	CIT10	2	1,200	0	0
*TOTAL CIH		2	1,200	0	0
CON	2033C	1	300	0	0
	5211C	1	500	0	0
*TOTAL CON		2	800	0	0
COT	310	3	4,358	10	116
	320	9	29,400	90	0
	EX300	1	500	0	0
	EX40	2	2	0	0
*TOTAL COT		15	34,260	100	116
CRC	ENA12	2	600	0	0
*TOTAL CRC		2	600	0	0
CSY	2700	391	398,801	2,264	24,171
	2710	58	87,823	1,081	2,902
	2711	7	8,550	0	1,161
	2721	2	3,350	46	267
	2742	37	57,385	957	1,768
	8702	2	5,750	0	319
	8742	112	213,620	2,411	16,780
*TOTAL CSY		609	775,279	6,759	47,368

Figure 2-8 Terminal Devices Summary

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF TERMINALS AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF TERMINALS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
DEC	LA36	1	1,700	0	0
*TOTAL DEC		1	1,700	0	0
DEQ	LA12	4	8,800	0	556
	LA120	5	4,004	39	0
	LA36	3	5,151	0	0
	VT100	43	69,507	1,240	0
	VT102	8	33,200	0	0
	VT50	1	1,500	0	0
	VT52	5	9,300	20	0
	VT55	2	15,980	0	0
*TOTAL DEQ		71	147,442	1,299	556
DIB	630	2	6,000	0	0
*TOTAL DIB		2	6,000	0	0
DIL	604	1	1	0	0
*TOTAL DIL		1	1	0	0
DTA	100	10	16,349	14	495
*TOTAL DTA		10	16,349	14	495
EAI	1420	1	6,000	0	0
*TOTAL EAI		1	6,000	0	0
GEL	TN200	3	3,600	0	677
*TOTAL GEL		3	3,600	0	677
HAZ	1420	2	1,700	0	0
	1500	17	12,592	0	248
	1510	1	850	0	0
	5000	1	900	0	0
	MOD 1	1	1,500	0	0
*TOTAL HAZ		22	17,542	0	248
HET	4101	8	48,400	1,096	0
*TOTAL HET		8	48,400	1,096	0
HIC	BT720	1	1,020	0	0
*TOTAL HIC		1	1,020	0	0

Figure 2-8 Terminal Devices Summary (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF TERMINALS AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF TERMINALS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
HPC	1335A	2	2	0	0
	2600	2	8,900	0	0
	2600A	3	8,149	32	0
	2615A	1	1	0	0
	2621	4	5,715	0	0
	2621A	1	5,500	26	0
	2621P	2	1,401	0	0
	2622	6	11,800	96	0
	2623	6	23,450	0	0
	2623A	1	1	0	0
	2633	1	4,050	0	0
	2635A	5	14,058	31	0
	2640	1	2,500	40	0
	2640A	6	14,652	19	0
	2642A	1	5,533	0	0
	2644A	7	36,700	179	0
	2645A	18	81,943	232	0
	2646A	1	8,000	0	0
	2647	2	17,200	0	0
	2647A	2	7,305	0	0
	2648	1	8,655	0	0
	2648A	22	143,688	375	0
	2649	1	4,385	0	0
	2703	1	15,721	0	0
	2752	3	11,350	0	0
	2752A	1	1	0	0
	2754	1	2,000	0	0
	5460A	4	4	0	0
	5475A	1	1	0	0
	7220T	1	4,600	0	0
	9866A	1	6,000	16	0
	9866B	1	3,216	18	0
*TOTAL HPC		110	456,481	1,064	0
IBM	2821	2	77,790	339	0
	3277	1	28,000	0	0
	3278	3	4,763	80	120
	5028	5	11,817	295	0
	5135	3	900	0	0
	5151	2	600	0	0
	5153	3	1,200	0	0
*TOTAL IBM		19	125,070	714	120
ITE	7051	3	2,300	22	0
*TOTAL ITE		3	2,300	22	0
LSI	ADM	95	116,522	400	7,804
	ADM32	1	1,078	0	0

Figure 2-8 Terminal Devices Summary (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF TERMINALS AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF TERMINALS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
LSI	ADM36	2	4,192	0	0
	ADM3A	5	4,340	0	0
*TOTAL LSI		103	126,132	400	7,804
PKE	1100	2	2,200	0	0
	1251	1	600	0	0
	550	5	3,975	0	0
	M46	25	33,100	0	0
	OWL12	2	2	0	0
*TOTAL PKE		35	39,877	0	0
RAO	1	1	1	0	0
	B025	3	3,000	0	456
*TOTAL RAO		4	3,001	0	456
SRO	140	1	1,495	0	0
*TOTAL SRO		1	1,495	0	0
TEK	4002	1	8,800	0	0
	4002A	2	25,238	195	0
	4010	6	72,248	44	0
	4012	15	167,648	25	0
	4014	20	285,533	1,020	650
	4016	1	18,000	0	0
	4027	2	4,174	195	0
	4041	1	14,807	0	0
	4051	2	10,856	0	282
	4109	1	8,002	0	0
	4112	1	6,500	0	0
	4112B	3	16,380	0	0
	4113	2	44,136	396	3,336
	4115	3	74,466	582	0
	4631	1	4,295	0	0
	4632	3	7,290	132	0
	613	2	3,196	0	0
*TOTAL TEK		66	771,569	2,589	4,268
TEL	33TU	1	850	0	0
	ASR	4	19,570	206	0
*TOTAL TEL		5	20,420	206	0
TEX	735	1	2,103	28	0
	745	17	18,161	56	1,476
	765	138	182,485	30	14,934
	770	1	9,000	0	0

Figure 2-8 Terminal Devices Summary (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF TERMINALS AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF TERMINALS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
TEX	OMNI	1	2,155	0	0
*TOTAL TEX		158	213,904	114	16,410
TLG	5705	1	45,500	263	1,944
	5800	51	61,200	102	2,550
*TOTAL TLG		52	106,700	365	4,494
TVD	25	1	750	0	0
	950	1	1,860	0	0
*TOTAL TVD		2	2,610	0	0
UNI	3542	2	11,344	0	1,030
*TOTAL UNI		2	11,344	0	1,030
VEG	MT	6	8,778	0	0
*TOTAL VEG		6	8,778	0	0
VIT	VISUL	52	54,600	0	4,212
*TOTAL VIT		52	54,600	0	4,212
WAN	722	1	1,000	0	0
*TOTAL WAN		1	1,000	0	0
ZEN	CBH	7	42,000	280	0
	CHB	3	18,000	120	0
	VT55	1	1,236	11	0
	WH19	2	16,000	0	0
*TOTAL ZEN		13	77,236	411	0
TOTAL		1405	3,246,842	16,379	88,254

Figure 2-8 Terminal Devices Summary (Cont'd)

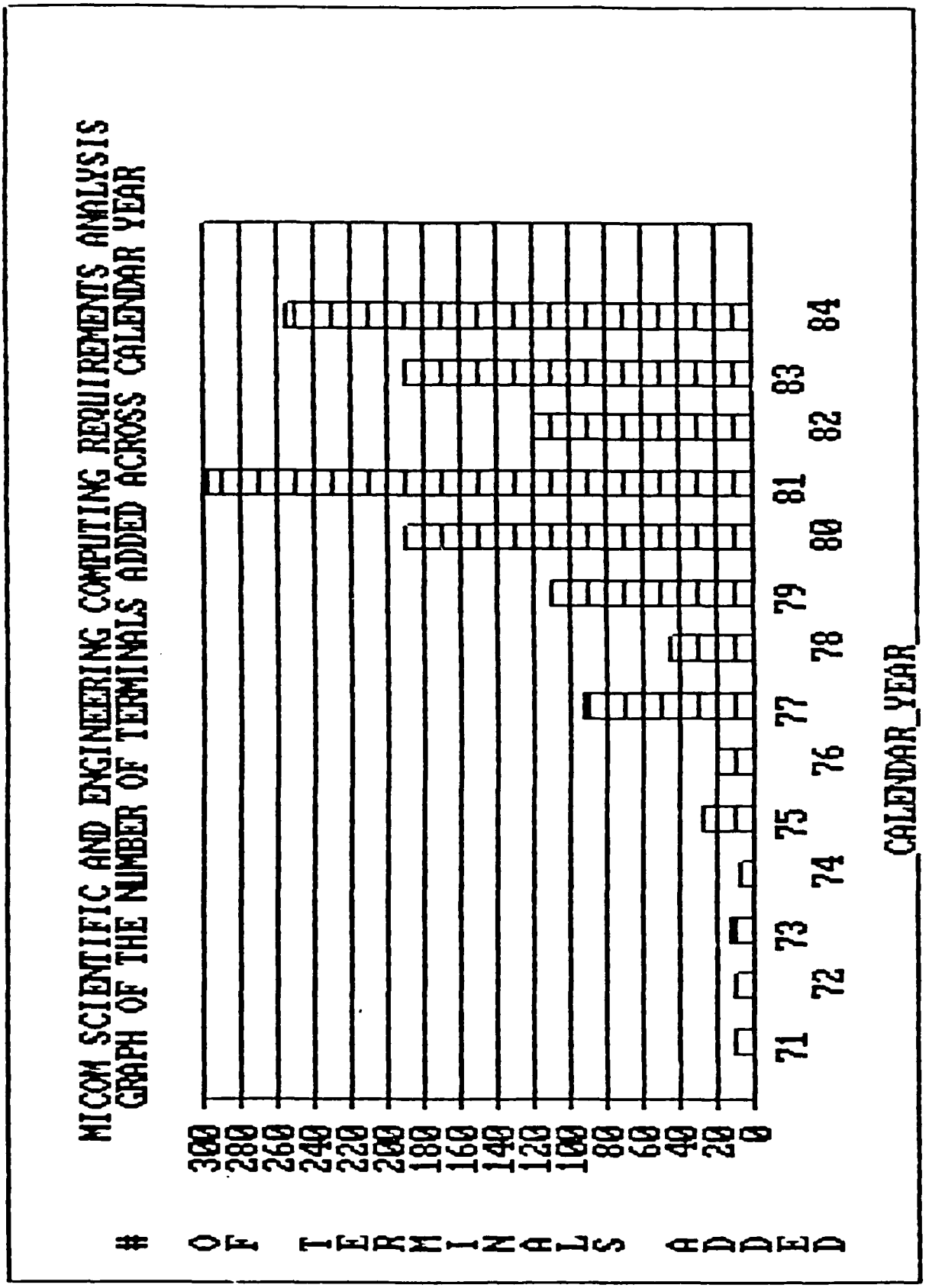

Figure 2-9 Historic Demand for Terminal Devices

2.1.6 Current Graphics Device Support Analysis

The S&E Community utilizes a variety of hard copy graphics devices (Plotters) in addition to the variety of terminal graphics devices that were included in the terminals discussed in Section 2.1.5. Among these are: drum plotters; flatbed plotters; pen plotters (1,2,4,6 and 8 pen); drafting plotters; graphics tablets; light pens; digitizers; thermal, impact and dot matrix graphics printers; to name a few of them. These graphics devices come in a wide variety of shapes, sizes and capabilities. They range from s ll desktop models to small portable models, and, through large space consuming models requiring carefully controlled environmental conditions. They range in capability from producing small 8.5 inch rectangular plots through the capability to produce A through E-size engineering drawings. Collectively, the devices support the production of high-resolution Engineering Graphics, Engineering Management Graphics, Presentation Graphics; and, what has become known as, Business and Data Analysis Graphics (Bar Charts, Pie Charts, Gantt Charts, Histograms, Scatter Diagrams and Connected Point Plots).

Figure 2-10 shows the number of graphics devices by Vendor and provides some summarized cost information. Figure 2-11 shows the growth in the demand for sophisticated hard copy graphics devices over the calendar years. Both figures use data obtained from the DARCOM ADPE Inventory Report. Figure 2-10 shows that most of the substantial graphics devices are provided by the following vendors: Hewlett-Packard, Tektronix, Versatec and Calcomp. An analysis of the terminals inventoried in Figure 2-8, shows that about 40% of the terminals are either graphics terminals, or support some terminal graphics capabilities. The graphics printers are included in the "PRINTER" inventory provided as Figure 2-19.

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF GRAPHICS EQUIPMENT AND COST SUMMARY BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF GRAPHICS UNITS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
CAL	565	1	1,500	0	0
	936	1	20,000	0	0
*TOTAL CAL		2	21,500	0	0
HIC	3000	1	1	0	0
	DP3	5	11,075	0	0
*TOTAL HIC		6	11,076	0	0
HPC	7004A	1	1	0	0
	7210	1	3,200	0	0
	7210A	7	10,204	88	0
	7225A	2	3,845	0	0
	7270	1	1,200	0	0
	7470	9	8,495	415	0
	7470A	2	1,501	0	0
	9125A	1	2,475	24	0
	9125B	1	2,400	0	0
	9862A	24	74,784	506	0
	9871A	1	1	28	0
	9872	26	114,563	494	0
	9872A	8	33,376	140	0
	9872B	6	25,880	165	0
	9872C	2	501	0	0
	9872S	2	21,750	68	0
*TOTAL HPC		94	304,176	1,928	0
TEK	4662	4	14,496	129	320
	4663	2	21,155	0	0
	4956	1	8,890	0	0
*TOTAL TEK		7	44,541	129	320
VAR		1	12,000	0	0
	4211	1	11,900	0	0
*TOTAL VAR		2	23,900	0	0
VES	8236	1	8,000	0	0
	D1200	1	10,680	0	0
	V80-7	1	8,075	0	0
	V8021	1	13,213	0	0
*TOTAL VES		4	39,968	0	0
WAN	702	1	3,378	0	0
*TOTAL WAN		1	3,378	0	0
TOTAL		116	448,639	2,057	320

Figure 2-10 Graphics Devices Summary

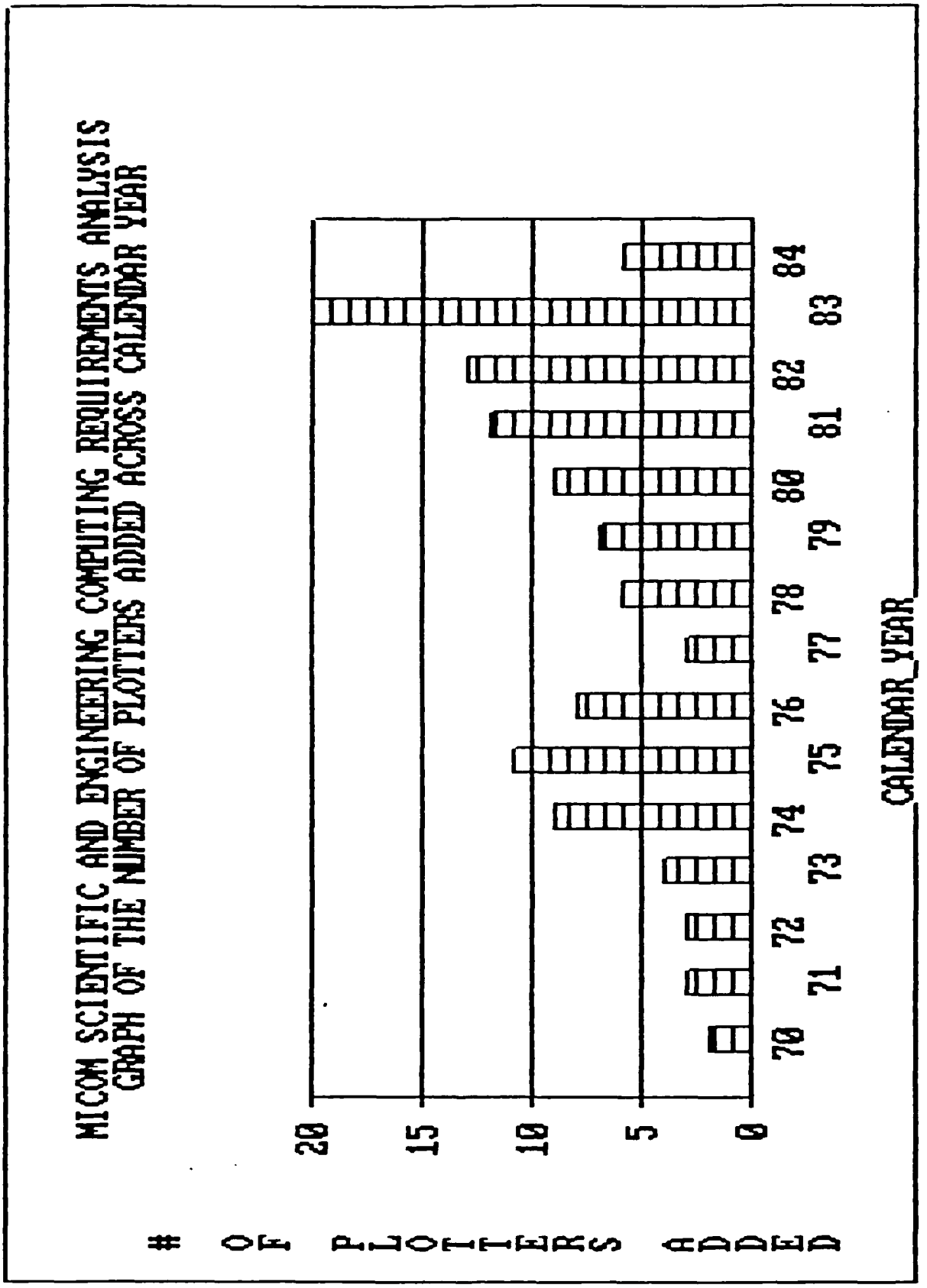

Figure 2-11 Historic Demand for Graphics Devices

The data collected from the survey showed that an increasing demand for graphics support exists within the S&E Community. The general opinion of the S&E Community is that the graphics area is not very well supported, at the mainframe, mini and micro level of computers, on the Arsenal. At the mainframe level, the graphics software that is available is difficult to use and really can only be utilized by people with good programming skills. No state-of-the-art "User Friendly" graphics hardware and software is readily available from IMD, nor does any modern graphics capabilities exist at the S&E Computing Center. Furthermore, the software that is available (TEKTRONIX, DISSPLA, and IMSL plot) doesn't run very well, because of the relatively slow CPU speed, and the lack of sufficient central memory and lack of an interactive Virtual Operating System, which can adequately support many INTERACTIVE Graphics Users. Keep in mind that NOS/BE was designed as a BATCH operating system for the CDC; and, that INTERCOM (which supports interactive terminal Users) was added as an *after-thought*. *Eventually*, MICOM must migrate the S&E Computing workload to a state-of-the-art Virtual Operating System and considerably faster hardware than is currently utilized. At the mini and micro levels of hardware, the graphics software is excellent; but, the CPU speeds are too slow, and, in some cases, sufficient memory is not available to adequately support a large number of Graphics Users. In some areas, the plotting devices used are too slow and are in need of upgrading to state-of-the-art graphing speeds.

In conclusion, a S&E Graphics Modernization program should be initiated by IMD to bring state-of-the-art graphics capabilities to the S&E End-Users across levels of hardware. Complete hardware, software and support services in the graphics area should be provided on a turnkey basis across the spectrum of graphics requirements. This turnkey service should begin at the S&E

Central Computing Facility and eventually work its way out into the End-User's application areas. A more detailed study of the graphics requirements should be performed, soon.

2.1.7 Current Other Peripheral Device Analysis

The S&E Community is supported by a variety of other peripheral devices. Among these are general purpose devices like: card readers, card punches, paper-tape readers and punches, magnetic tape, magnetic disk, and line printers; and, more specialized devices like: Analog to Digital Converters, Digital to Analog Converters, Computer Output to Microfilm and Microfiche, Optical Mark Readers, Film Processors and Projectors, and a variety of Test, Measurement and Control devices that are interfaced to digital and analog computers.

The DARCOM ADPE Inventory Report contained 127 pieces of equipment that we classified into the category of 'CARD READERS AND CARD PUNCHES.' Figures 2-12 and 2-13 show the variety of card related devices by Vendor and provide summarized cost information. Figure 2-14 shows the historic demand for card related devices, over the calendar years. Card readers, card punches and keypunch machines are located in the Central Computing Facility, in remote minicomputer computer centers, at Remote Job Entry workstation locations, and other work areas throughout the Arsenal. The data shows that MICOM has an investment of a little over 720 thousand dollars in card-related equipment. Figure 2-14 shows that most of the equipment is very old and obsolete. The older machines should be replaced with more modern equipment, which consume less electricity, occupy less physical space, and are less of a maintenance headache.

The DARCOM ADPE Inventory Report revealed 176 tape drives provided by 21 different Vendors and 391 disk drives provided by 29 different Vendors. Figures 2-15 and 2-16 show the variety of magnetic tape and magnetic disk devices utilized by the Command, and provide summarized cost information by

Vendor and Model. Figure 2-15 shows a capital investment of 2.38 million dollars in magnetic tape devices. Figure 2-16 shows a capital investment of 5.12 million dollars in magnetic disk devices. Figure 2-17 shows the historic demand for magnetic tape devices and Figure 2-18 shows the historic demand for magnetic disk devices. Figures 2-17 and 2-18 indicate that much of the magnetic tape and disk equipment is old and is in need of replacement with more modern and efficient equipment. Further analysis, of the data tabulated, shows that only a little more than 50% of the expenditures for tape and disk are related to the large Central Computing Facilities (i.e., the CDC and IBM). A higher percentage of funds should be spent on the Central Computing Facilities in order to make them more attractive to the potential User Community.

The DARCOM ADPE Inventory Report contained 477 pieces of equipment that we classified into the category of "PRINTERS." The 'PRINTER' category included the spectrum of printer devices ranging from the high-speed line printers found in the Central and Remote Computing Centers, to the printers located at Remote Job Entry sites; and through the variety of low-speed line printers and printer/plotter devices that are scattered throughout the User's work areas. The printers are provided by forty different equipment Vendors. The summarized inventory and cost information is provided in Figure 2-19. Figure 2-20 shows the historic growth in the demand for printer devices. Figure 2-19 shows a capital investment of 2.5 million dollars in printer devices. Approximately 50% of the "PRINTER" devices identified support some graphics capabilities.

A more detailed analysis of the other Scientific and Engineering computing equipment was beyond the scope of the contract. But, the

information provided in Section 2.1 provides some useful quantification of the dollars that have been spent on ADPE by MICOM; and, helps to develop some quantification parameters regarding the extent of the ADP and telecommunications problems that have developed at Redstone Arsenal over the past ten years. A careful review of the past can help to avoid future problems of the same nature.

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF CARD READERS AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF CARD READERS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
CDC	182	1	1	0	0
	1829	1	2,238	45	0
	224	13	58,140	767	0
	242	1	4,632	59	0
	405	2	31,037	166	0
	734	2	5,465	66	0
*TOTAL CDC		20	101,513	1,103	0
CMC	1601	3	12,825	150	0
	1641	3	2,850	30	0
*TOTAL CMC		6	15,675	180	0
DEQ	CR11	3	18,540	123	0
	LA36	1	3,500	0	0
*TOTAL DEQ		4	22,040	123	0
DOC	200	3	6,221	53	0
	LC50	1	30,000	0	0
	M200	4	14,170	56	0
	M300	1	1	0	0
*TOTAL DOC		9	50,392	109	0
DTA	100	11	38,667	72	1,080
*TOTAL DTA		11	38,667	72	1,080
EAI	1525	1	4,050	0	0
*TOTAL EAI		1	4,050	0	0
HCS	3110	1	4,000	0	0
*TOTAL HCS		1	4,000	0	0
HPC	12986	1	4,100	79	0
	2892A	1	5,000	64	0
	7260	1	5,037	0	0
	7261A	2	9,500	0	0
	9160A	1	490	5	0
	9869A	1	3,000	0	0

Figure 2-12 Card Readers Summary

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF CARD READERS AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF CARD READERS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
*TOTAL HPC		7	27,127	148	0
IBM	3505	2	81,750	728	2,800
*TOTAL IBM		2	81,750	728	2,800
UNI	0716	2	31,008	282	0
*TOTAL UNI		2	31,008	282	0
UPT	400	1	12,000	0	0
*TOTAL UPT		1	12,000	0	0
VAR	6200	1	4,500	0	0
*TOTAL VAR		1	4,500	0	0
TOTAL		65	392,722	2,745	3,880

Figure 2-12 Card Readers Summary (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF CARD PUNCHES AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF CARD PUNCHES	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
CDC	415	2	21,106	154	0
*TOTAL CDC		2	21,106	154	0
DTA	100	1	3,990	99	0
*TOTAL DTA		1	3,990	99	0
IBM	1402	1	24,500	102	0
	26	35	107,470	765	0
	29	17	44,399	539	0
	3525	2	90,544	468	2,550
*TOTAL IBM		55	266,913	1,874	2,550
UNI	0604	1	26,640	198	0
	1610	3	9,024	148	150
*TOTAL UNI		4	35,664	346	150
TOTAL		62	327,673	2,473	2,700

Figure 2-13 Card Punches Summary

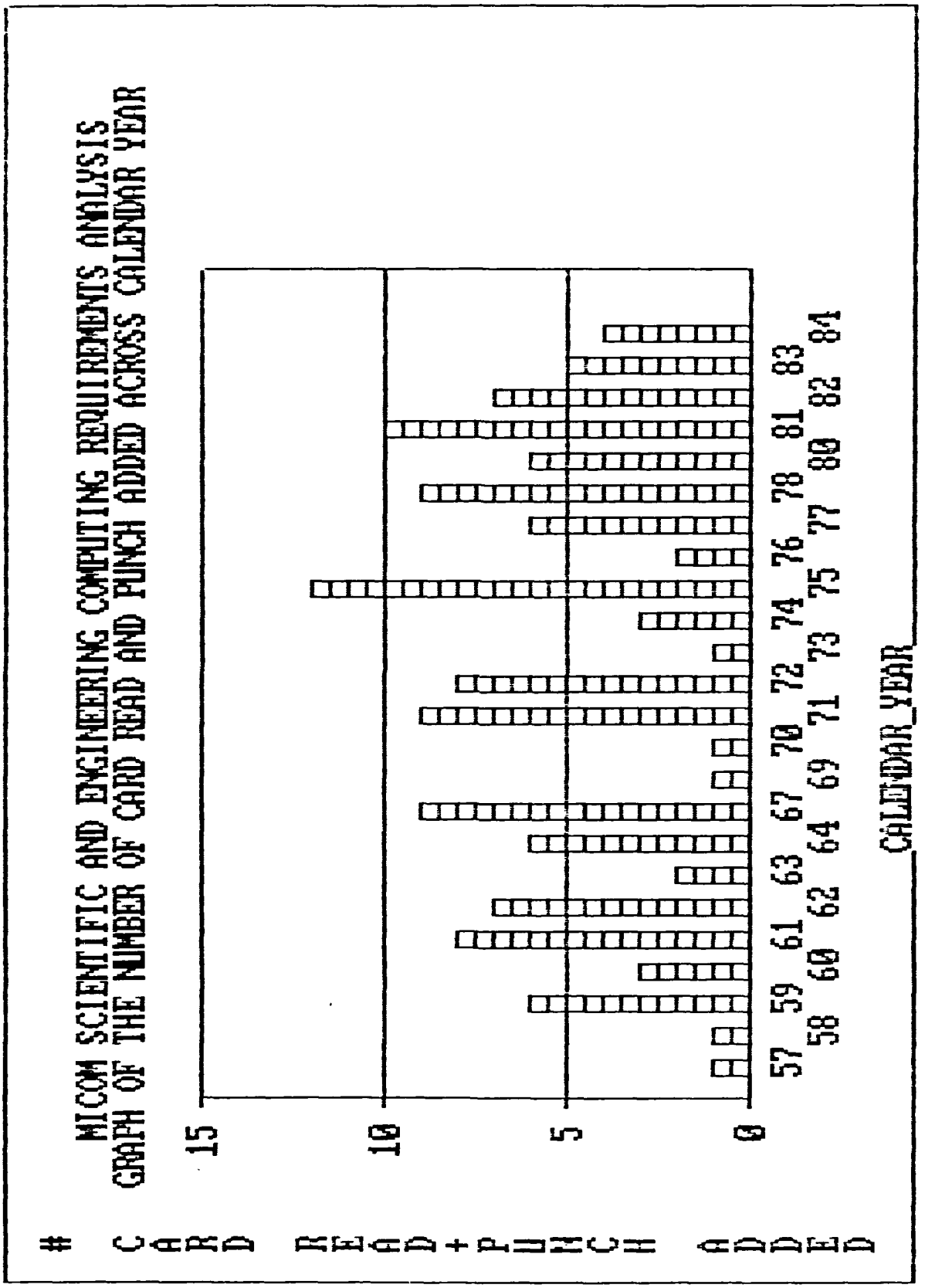

Figure 2-14 Historic Demand for Card Devices

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF MAG TAPE UNITS AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF MAG TAPE UNITS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
AMP	TMB05	1	9,000	0	0
*TOTAL AMP		1	9,000	0	0
CDC	603	8	73,000	0	0
	606	1	5,000	0	0
	607	8	203,992	1,872	0
	657	6	72,702	1,146	0
	659	2	17,554	526	1,652
	BW303	1	1	0	0
*TOTAL CDC		26	372,249	3,544	1,652
CEQ	TMA11	1	13,264	0	0
*TOTAL CEQ		1	13,264	0	0
CMC	1316	3	17,100	150	0
*TOTAL CMC		3	17,100	150	0
DDA	1737	1	5,500	0	0
	1739	1	5,500	0	0
*TOTAL DDA		2	11,000	0	0
DEQ	66	2	10,000	0	0
	TA11	3	9,635	38	0
	TE10W	1	9,000	0	0
	TM11	1	14,134	101	0
	TMA11	1	14,134	101	0
	TU10	3	30,600	0	0
	TU10M	1	10,000	0	0
	TU45	1	12,000	0	0
	TU77	3	94,000	457	0
	TU78	1	45,000	0	0
*TOTAL DEQ		17	248,503	697	0
DGC	6021	2	14,652	0	0
*TOTAL DGC		2	14,652	0	0
DTM	CM475	1	6,000	50	0

Figure 2-15 Magnetic Tape Devices Summary

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF MAG TAPE UNITS AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF MAG TAPE UNITS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
DTM	TDI	1	12,780	0	0
*TOTAL DTM		2	18,780	50	0
EAI	1727	1	23,000	0	0
	T6640	1	12,000	0	0
*TOTAL EAI		2	35,000	0	0
HCS	6640	2	24,000	0	0
*TOTAL HCS		2	24,000	0	0
HPC	7970	4	40,814	137	0
	7970B	26	186,181	892	0
	7970E	2	2	0	0
	9865A	3	5,312	26	0
*TOTAL HPC		35	232,309	1,055	0
IBM	3420	47	753,768	3,086	0
	729	5	163,400	443	0
*TOTAL IBM		52	917,168	3,529	0
IFD	R461	1	11,000	0	0
*TOTAL IFD		1	11,000	0	0
KEN	9000	1	14,000	180	0
	9100	2	18,771	50	0
	9300	2	13,600	0	0
	9700	1	1	0	0
*TOTAL KEN		6	50,372	230	0
PEC	6840	1	17,870	82	0
*TOTAL PEC		1	17,870	82	0
PET	T9640	1	1	0	0
	T9840	1	1	0	0
*TOTAL PET		2	2	0	0

Figure 2-15 Magnetic Tape Devices Summary (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF MAG TAPE UNITS AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF MAG TAPE UNITS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
PKE	M46	2	31,706	0	0
	M4653	1	19,100	0	0
*TOTAL PKE		3	50,806	0	0
TEK	4923	2	4,155	0	0
	CP101	1	14,440	111	0
*TOTAL TEK		3	18,595	111	0
UNI	0872	10	288,900	2,110	0
*TOTAL UNI		10	288,900	2,110	0
VAR	7102	1	7,600	0	0
*TOTAL VAR		1	7,600	0	0
WAN	729	1	3,000	0	0
	CM475	1	4,400	50	0
	CWG10	1	4,000	75	0
	CWG11	1	7,700	100	0
*TOTAL WAN		4	19,100	225	0
TOTAL		176	2,377,270	11,783	1,652

Figure 2-15 Magnetic Tape Devices Summary (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF DISK UNITS AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF DISK UNITS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
AMD	6280	4	188,400	349	3,926
*TOTAL AMD		4	188,400	349	3,926
AMP	980	1	1	0	0
	DM890	1	10,000	0	0
	DM980	2	19,000	0	0
*TOTAL AMP		4	29,001	0	0
AMR	AM500	1	8,400	0	0
*TOTAL AMR		1	8,400	0	0
APM	A2M	2	1,000	0	0
	A2M00	1	800	0	0
*TOTAL APM		3	1,800	0	0
ATA	810	1	250	0	0
*TOTAL ATA		1	250	0	0
CAL	CCT20	6	144,000	1,500	0
	CMT10	2	36,000	600	0
*TOTAL CAL		8	180,000	2,100	0
CBM	2040	3	2,800	0	0
	2044	1	800	0	0
	4040	1	1,000	0	0
	8050	1	1,000	0	0
*TOTAL CBM		6	5,600	0	0
CDC	1867	2	36,200	0	0
	33302	8	192,000	2,000	0
	33332	1	1	0	0
	38302	1	18,000	300	0
	6638	1	173,385	1,169	0
	844	20	129,054	2,088	0
	9434	12	300,000	3,012	0
	9762	2	30,000	0	0
	9766	4	60,000	0	0
*TOTAL CDC		51	938,640	8,569	0

Figure 2-16 Magnetic Disk Devices Summary

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF DISK UNITS AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF DISK UNITS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
CMC	1225	4	66,295	400	0
*TOTAL CMC		4	66,295	400	0
DEQ	33FK5	2	8,000	242	0
	715D	1	34,000	0	0
	FT012	1	1	0	0
	REM03	2	44,000	0	0
	RK05	7	36,400	0	0
	RK05J	2	10,700	39	0
	RK06	1	13,100	0	0
	RK11	1	7,975	0	0
	RL01	4	10,002	128	0
	RL02	3	9,000	0	0
	RM05	3	103,000	473	0
	RP06	3	87,800	476	0
	RX01	1	7,000	0	0
	RX02	1	4,000	48	0
*TOTAL DEQ		32	374,978	1,406	0
DGC	4047	1	5,810	0	0
	4237	1	9,810	0	0
	6061	1	31,000	0	0
*TOTAL DGC		3	46,620	0	0
DIB	33	3	23,500	170	0
	4237	1	1	0	0
*TOTAL DIB		4	23,501	170	0
EAI	1272	1	15,000	0	0
*TOTAL EAI		1	15,000	0	0
HCS	5260A	1	12,900	0	0
*TOTAL HCS		1	12,900	0	0
HPC	12732	2	9,300	68	0
	12733	2	5,800	36	0
	7900	2	20,975	0	0
	7900A	14	121,637	490	0
	7903A	7	64,831	238	0
	7906	13	180,740	563	0
	7906M	13	164,502	825	0

Figure 2-16 Magnetic Disk Devices Summary (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF DISK UNITS AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF DISK UNITS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
HPC	7906S	1	11,000	0	0
	7908	4	51,650	117	0
	7914	1	10,000	0	0
	7920	2	34,000	167	0
	7920A	2	26,000	150	0
	7920B	3	46,200	81	0
	7925	1	19,000	0	0
	7925B	2	34,000	130	0
	7925M	1	22,000	89	0
	7925S	1	17,000	80	0
	8290	7	8,500	0	0
	82901	3	3,000	0	0
	9134	3	12,825	18	0
	9708	1	2,500	0	0
	9835	2	22,000	0	0
	9885	7	24,558	166	0
	9885M	5	18,426	91	0
	9885S	7	14,553	110	0
	9895	3	17,025	61	0
	9895A	2	5,500	0	0
*TOTAL HPC		111	967,522	3,480	0
IBM	3380	2	137,270	325	2,675
	3880	2	183,669	359	3,807
	5022	4	27,526	422	0
	5026	1	4,000	71	0
*TOTAL IBM		9	352,465	1,177	6,482
IEL	MDS	1	1,300	0	0
*TOTAL IEL		1	1,300	0	0
IMA	FDC22	1	2,500	0	0
*TOTAL IMA		1	2,500	0	0
INE	FD30	1	1	0	0
*TOTAL INE		1	1	0	0
ITE	7330	114	927,532	17,812	0
*TOTAL ITE		114	927,532	17,812	0
KEN	5300	1	4,000	64	0

Figure 2-16 Magnetic Disk Devices Summary (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF DISK UNITS AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF DISK UNITS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
*TOTAL KEN		1	4,000	64	0
MOT	FD360	1	3,510	0	0
	M68DS	1	5,195	0	0
	MDOS	1	5,195	0	0
*TOTAL MOT		3	13,900	0	0
PKE	M60	6	184,260	0	0
	MSM	1	30,340	0	0
	MSM30	1	37,000	0	0
	MSM80	2	47,000	0	0
*TOTAL PKE		10	298,600	0	0
PSI	277	1	1,600	0	0
*TOTAL PSI		1	1,600	0	0
ROS	26116	2	798	0	0
*TOTAL ROS		2	798	0	0
TEK	4907	1	5,072	62	0
	CP110	2	16,965	232	0
*TOTAL TEK		3	22,037	294	0
UNI	8450	8	596,800	2,336	0
*TOTAL UNI		8	596,800	2,336	0
VAR	7553	2	32,000	0	0
*TOTAL VAR		2	32,000	0	0
WAN	F122	1	6,100	0	0
*TOTAL WAN		1	6,100	0	0
TOTAL		391	5,118,540	38,157	10,408

Figure 2-16 Magnetic Disk Devices Summary (Cont'd)

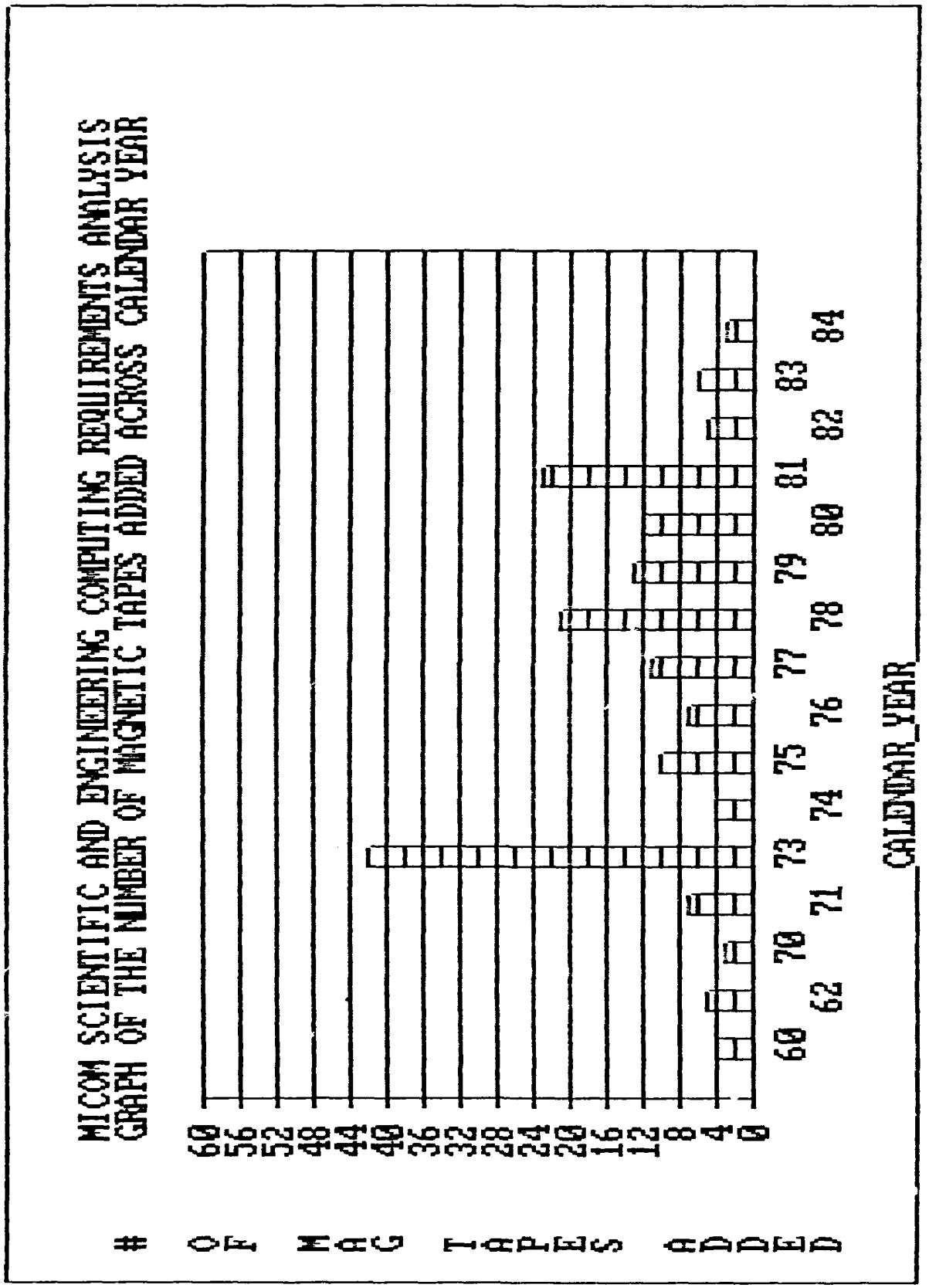

Figure 2-17 Historic Demand for Magnetic Tape Devices

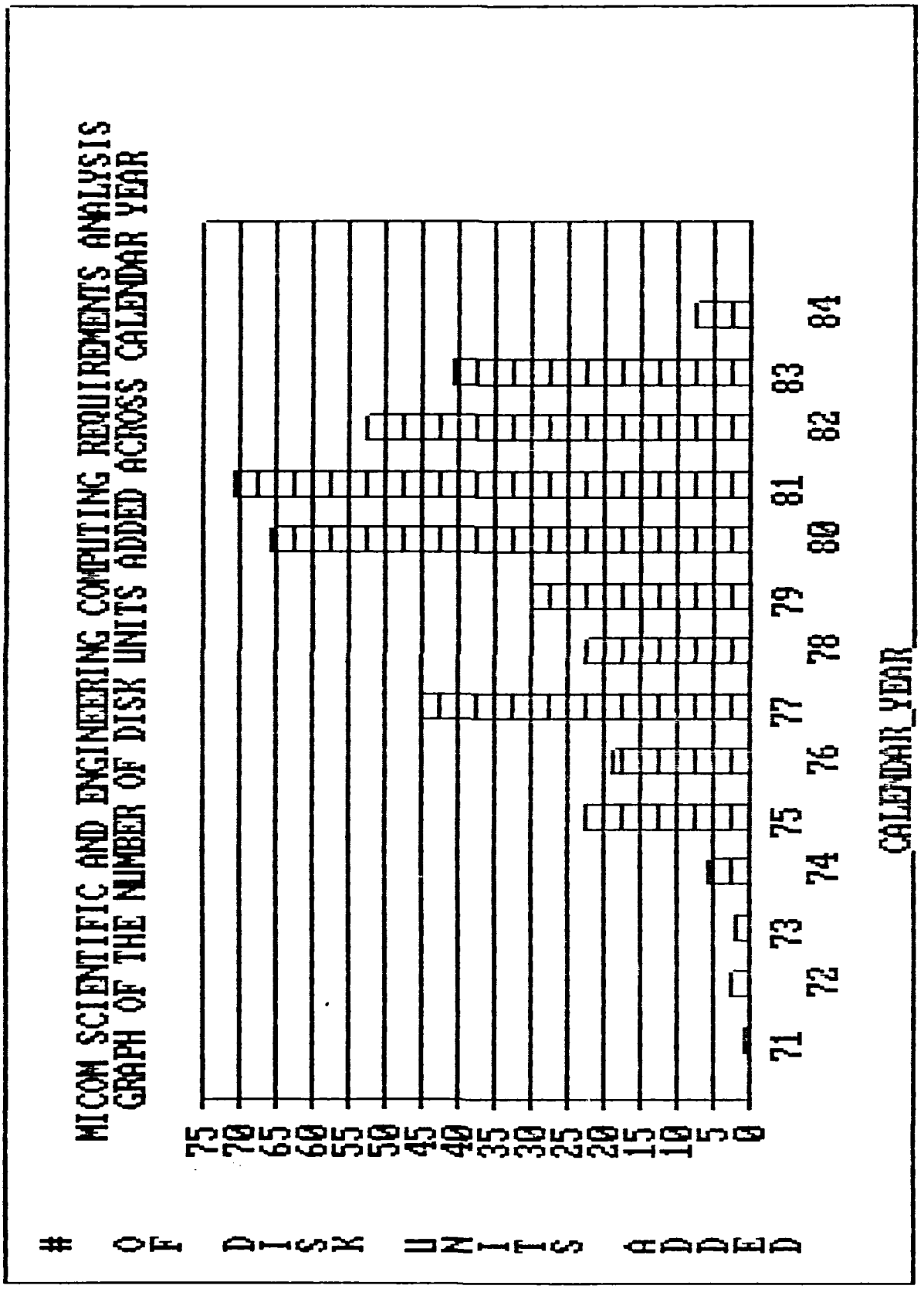

Figure 2-18 Historic Demand for Magnetic Disk Devices

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF PRINTERS AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF PRINTERS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
ANL	1995	1	25,000	0	0
*TOTAL ANL		1	25,000	0	0
CBM	2020	1	800	0	0
	2022	5	5,095	0	0
	4020	1	800	0	0
	4022	1	1,000	0	0
*TOTAL CBM		8	7,695	0	0
CDC	1827	1	7,849	90	0
	218	2	5,205	78	0
	222	8	145,884	2,248	0
	512	3	71,421	970	751
	734	2	12,499	416	0
	LPM	1	1	0	0
*TOTAL CDC		17	242,859	3,802	751
CEN	6600	1	13,000	125	0
	737	1	995	0	0
*TOTAL CEN		2	13,995	125	0
CMC	1781	3	9,690	105	0
	1786	3	7,125	60	0
*TOTAL CMC		6	16,815	165	0
CSY	8"10	4	11,695	135	147
	8720	1	4,465	0	221
	8742	1	4,220	0	207
*TOTAL CSY		6	20,380	135	575
DAF	4043	1	18,000	0	0
*TOTAL DAF		1	18,000	0	0
DEQ	11	1	1	0	0
	3	1	2,395	0	0
	LA120	2	6,160	108	0
	LA34	64	83,783	0	4,526
	LA36	6	21,620	40	0
	LA36C	1	1	19	0
	LP11	3	69,500	521	0

Figure 2-19 Printer Device Summary

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF PRINTERS AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF PRINTERS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
DEQ	LXY02	1	32,000	0	0
	VT55F	1	1	0	0
*TOTAL DEQ		80	215,461	688	4,526
DIB	1620	2	6,869	33	0
	1640	12	32,191	231	565
	630	1	1,975	33	0
*TOTAL DIB		15	41,035	297	565
DPC	2230	2	16,950	72	0
	2260	1	11,000	0	0
	2410	1	17,695	472	0
*TOTAL DPC		4	45,645	544	0
DPL	DP55	1	2,195	0	200
*TOTAL DPL		1	2,195	0	200
DTA	100	7	87,834	263	5,310
	10076	9	145,908	0	4,437
*TOTAL DTA		16	233,742	263	9,747
EAI	1630	1	19,500	0	0
*TOTAL EAI		1	19,500	0	0
EPA	FX100	1	900	0	0
	FX80	8	6,200	0	0
	MX1	1	1,000	0	0
	MX80	3	2,235	0	0
	RX80	1	385	0	0
*TOTAL EPA		14	10,720	0	0
GEL	TERMI	1	5,500	0	0
	TN340	1	1,800	0	393
*TOTAL GEL		2	7,300	0	393
GOU	4800	1	12,000	0	0
	5000	1	10,000	0	0
*TOTAL GOU		2	22,000	0	0

Figure 2-19 Printer Device Summary (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF PRINTERS AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF PRINTERS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
HCS	4120	1	19,110	0	0
*TOTAL HCS		1	19,110	0	0
HET	3136	8	16,800	800	0
*TOTAL HET		8	16,800	800	0
HPC	12975	1	11,475	133	0
	2601	4	8,000	0	0
	2601A	2	3,340	0	0
	2602	5	5,560	345	0
	2607A	6	53,225	230	0
	2608	3	27,908	72	0
	2608A	15	145,703	856	0
	2610A	1	4,000	0	0
	2613G	1	4,200	0	0
	2631	12	46,759	62	0
	26310	1	3,900	41	0
	2631A	4	10,571	83	0
	2631B	1	3,800	0	0
	2631G	4	15,960	68	0
	2671	2	5,360	0	0
	2752A	1	3,500	54	0
	2767	1	3,400	0	0
	2767A	5	53,648	304	0
	7245B	1	4,600	0	0
	7906	1	9,750	16	0
	8290	9	7,200	0	0
	82905	3	1,795	0	0
	9120A	1	975	21	0
	9861A	1	5,000	42	0
	9865A	1	2,975	0	0
	9866	3	9,845	0	0
	9866A	21	69,845	203	0
	9866B	1	3,200	16	0
	9871	2	6,800	0	0
	9871A	6	22,844	158	0
*TOTAL HPC		119	555,138	2,704	0
IBM	1403	5	104,796	725	0
	43	1	22,995	67	0
	3715	19	38,874	665	0
	7431	1	2,200	0	0
*TOTAL IBM		26	168,865	1,457	0

Figure 2-19 Printer Device Summary (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF PRINTERS AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF PRINTERS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
IEL	M200	1	2,865	0	0
*TOTAL IEL		1	2,865	0	0
ITE	7213	3	3,350	33	0
*TOTAL ITE		3	3,350	33	0
MOT	M68SP	1	3,125	0	0
*TOTAL MOT		1	3,125	0	0
NEC	3515	2	6,000	0	0
*TOTAL NEC		2	6,000	0	0
NIS	5510	1	3,250	0	0
*TOTAL NIS		1	3,250	0	0
OKI	CP110	6	14,400	240	0
*TOTAL OKI		6	14,400	240	0
PKE	LP300	1	9,000	0	0
	M46	9	18,619	0	0
*TOTAL PKE		10	27,619	0	0
PTX	C6000	6	60,000	600	0
*TOTAL PTX		6	60,000	600	0
QUM	SPT11	52	89,180	0	6,864
*TOTAL QUM		52	89,180	0	6,864
ROS	26115	1	799	0	0
	DMP21	1	1,995	0	0
*TOTAL ROS		2	2,794	0	0
TEK	4610	4	56,687	25	0
	4611	1	3,870	0	0
	4631	25	109,034	525	183
	4632	4	20,082	0	0
	4641	2	10,076	0	0

Figure 2-19 Printer Device Summary (Cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF NUMBER OF PRINTERS AND COST SUMMARY
BY VENDOR
FROM DARCOM ADPE INVENTORY REPORT

VENDOR	MODEL	NUMBER OF PRINTERS	PURCHASE PRICE	MONTHLY MAINTENANCE COST	MONTHLY RENTAL COST
TEK	4691	5	43,987	695	2,598
	CP146	1	3,585	55	0
*TOTAL TEK		42	247,321	1,300	2,781
TEL	ASR33	2	751	0	0
*TOTAL TEL		2	751	0	0
TEX	810	1	2,000	0	102
	820	2	2,214	0	190
*TOTAL TEX		3	4,214	0	292
TIM	TC71	1	40,895	0	0
*TOTAL TIM		1	40,895	0	0
TLY	1612	1	2,442	40	0
*TOTAL TLY		1	2,442	40	0
UNI	0770	3	194,688	1,230	0
	0786	3	21,612	59	428
*TOTAL UNI		6	216,300	1,289	428
VAR	4211	1	13,000	0	0
	6723	1	17,500	0	0
*TOTAL VAR		2	30,500	0	0
VER	1200	1	10,347	84	0
*TOTAL VER		1	10,347	84	0
VES	1200A	2	24,000	143	0
	800	1	7,200	0	0
*TOTAL VES		3	31,200	143	0
WAN	702	2	13,000	0	0
*TOTAL WAN		2	13,000	0	0
TOTAL		477	2,511,808	14,709	27,122

Figure 2-19 Printer Device Summary (Cont'd)

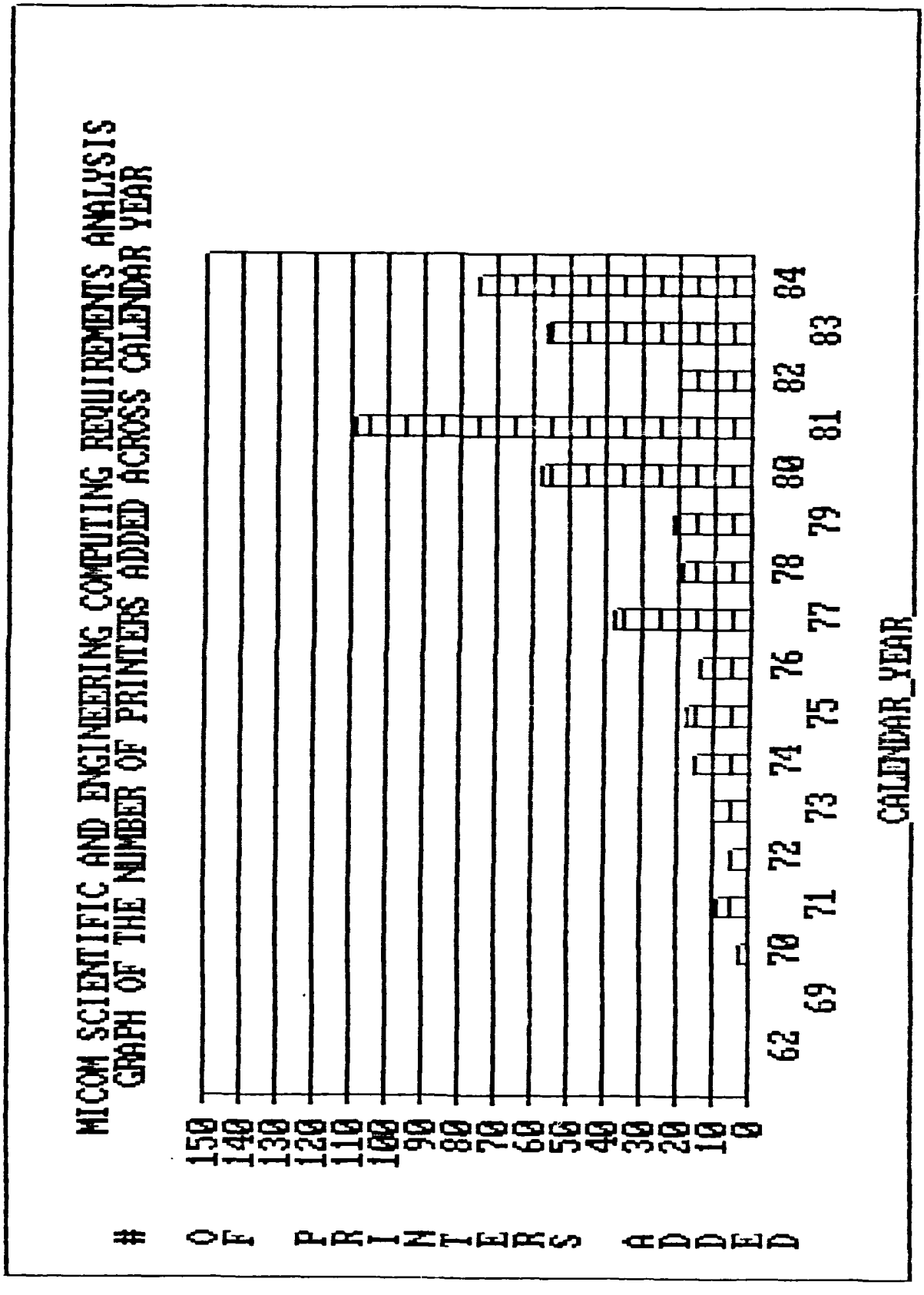

Figure 2-20 Historic Demand for Printer Devices

2.1.8 Current Communications Lines/Circuits

The data collected on the Organizational Level Questionnaire showed that there were only 235 communications lines/circuits used by the S&E Community. Of these 27% (63/235) were identified by IMD as being provided at the S&E Central Computing Facility. Many of the communications lines/circuits that exist at many of the remote computing centers were not identified during the study effort. The current number of circuits/lines in use, probably exceeds 1500, based upon the number of computers and terminals that exist on the Arsenal. The dedicated circuits are available at speeds of 1200 to 9600 BAUD. The dial-up circuits are available at 300 to 9600 BAUD.

The S&E Community voiced a strong negative opinion about the quality of the communications lines/circuits that are available. Basically, faster line speeds are needed. More dedicated lines are required. Data-Quality dial-up lines are needed the most across the Arsenal. High-speed local area networks are needed for data transmission, both on and off of the Arsenal. And, the User Community is expecting that IMD will provide these services.

2.1.9 Current Scientific and Engineering Computing User Community Analysis

The MICOM Scientific and Engineering Computing User Community is composed of individuals from the Functional Directorates, the Project Management Offices, Staff Offices, TMDE, and various contractors. The data collected on the Organizational Level Questionnaires showed that the current S&E Community was concentrated in the Functional Directorates and TMDE. It also showed that a relatively small number of individuals were already doing S&E Computing work in the Project Management Offices.

Figure 2-21 provides an aggregation of the survey data provided in response to Question 4-1, 4-2, 4-3 and 4-7 from the Organizational Level Questionnaires. The data was aggregated into three categories: AMCPM, AMSMI and AMXTM; and, a total was provided. The symbol AMCPM represents the Project Management Offices; AMSMI represents the Functional Directorates; and, AMXTM represents TMDE. Question 4-1 identified the number of individuals. Question 4-2 identified the number of individuals who are Computer Users. Question 4-3 identified the number of S&E Computer Users. Question 4-7 identified the number of Supercomputer Users. The data was requested by type of personnel: Civilian, Military, and Contractor for the current, near-term and long-term timeframes.

An analysis of the data tabulated shows that relatively small increases in the total number of staff are expected over the next ten years. But, the number of Computer Users will increase by about 44%, from 2,497 to 3,587 over the long-term; and the number of S&E Computing Users will increase by about 23%, from 1,622 to 1,993 over the long-term. The actual number of S&E Computing Users is currently estimated to be between the 1,622 S&E Users and the 2,497 Computer Users identified in the data, because of the lack of a clear-cut definition of what constitutes S&E Work vs. Business Applications. In addition, the sample data collected represented a little more than half of the number of people at MICOM (5061/9000). Thus, the numbers reflected by the data could possibly only reflect half of the true populations of Users. Over the long-term, the number of S&E Computing Users was estimated to be between the 1,993 S&E Users and the 3,587 Computer Users identified in the data collected; but, when additional contractor personnel are factored into the estimate, the number of S&E Computing Users approaches 4,000, over the next ten years.

In the long-term, the largest growth in the number of Computer Users is expected in the Project Management Offices, where the number of Computer Users is expected to more than double. Likewise, the number of S&E Computing Users in the Project Management Offices is expected to at least double. In the Functional Directorates, the data collected showed that the number of Computer Users is expected to grow by about 64%, and, the number of S&E Computing Users is expected to grow by about 34%. TMDE is expecting a modest growth of about 3% in the number of Computer Users and a less than 1% growth in the number of S&E Computing Users. But, when the lack of more detailed information on some of the larger Functional Directorates (the Missile Logistics Center, for example) is considered, the growth in the populations of Computer Users and S&E Computer Users in the Directorates is also expected to at least double.

Currently, the number of Supercomputer Users at MICOM is only nine individuals. But, over the long-term, a Supercomputer User Community of 175 individuals is expected to develop at MICOM. The Supercomputer User Community at MICOM will grow to 92 individuals over the next five years; and, then, almost double to 175 individuals over the following five years. An even greater growth can be expected in the size of the Supercomputer User Community, as the S&E Community evolves into a Computer User Community and begins to appreciate the benefits of Supercomputer CPU Speeds.

Figure 2-22 shows an aggregation of the responses given for Question 4-4, from the Organizational Level Questionnaires. Question 4-4 requested estimates of the number of S&E Computer Users across levels of computers (i.e., mainframes, minicomputers, microcomputers and word processing equipment). The data shows that 614 Users will need a mainframe level computer for their S&E work; 1,563 Users will need a minicomputer; 1,777 Users

will need a microcomputer; and 1,198 Users will need access to word processors. The number of Users identified at each level are believed to be mutually exclusive and therefore can be added together to determine a total number, because other data collected indicated: that 681 Users need to use Mainframes, Minis and Micros for their work; that 444 Users need to use Mainframes and Minis; that 1483 need to use Mainframes and Micros; and, that 1887 Users need to use Minis and Micros. Ultimately, it is expected that most Computer Users will have some interface needs to the mainframe level computers. Interestingly enough, the sum of 614, 1,563, and 1,777 is 3,954. This helps to corroborate the estimate of 4,000 Users, especially if the individuals in the PMOs actually do get more involved in doing more S&E Computer Applications. The User Community is planning to use the levels of computers that best satisfy their perception of their needs; and, most of the S&E Users perceive that most of their S&E Computing Requirements will be met by their own mainframes, minis and microcomputers, over the long-term. This statement is supported by the data provided in Figure 2-23, which shows the anticipated distribution of Users across machines belonging to various organizations. The highest number of Users are indicated for machines controlled by the individual organizations.

The structure of the S&E Community at MICOM is extremely complex. When this study began, the twenty-five organizations that were included in the survey were structured into more than 600 sub-organizational functional elements. Each sub-organizational element was established to perform a specific mission, in a specific functional area. The individuals found in these areas possess a broad variety of Scientific and Engineering skills, and have developed technical expertise in a variety of MACARS Professional/Technical Specialty Areas. Figures 2-24 and 2-25 show an

aggregation of the data provided in response to Question 5 on the Organizational Level Questionnaires. Question 5 requested a breakdown of an organization's equivalent man-year staff requirements by Engineering Disciplines and MACARS Specialty as they exist currently, and are expected to change over the near and long-term. Unfortunately, many respondents could not or would not provide the information requested for Question 5. But, the data provided did show some concentration of people in certain Engineering Disciplines and MACARS Speciality Areas. The data also showed areas in which near-term and long-term manpower growth is expected. Data provided on the User Level Questionnaires, established the fact that all MACARS Specialty Title Areas are supported directly or indirectly by computer applications programs. Thus, increases in the manpower area can be used to infer and substantiate, both increases in the population of S&E Computer Users and the number of computer applications in the S&E Areas. This, in turn, can be used to reason that a tremendous growth exists in the demand for larger and faster computers to satisfy the S&E Computing Workload.

The S&E User Community is very unhappy with the hardware, software and telecommunications capabilities that exist on the Arsenal. They are frustrated with the perceived non-responsiveness of IMD, as they seek out ways to satisfy their ADP needs. They detest the ADP procurement approval and paperwork process. They feel that the training provided does not meet the needs of the End-Users in different functional areas. And, they feel that the scope of IMD services does not adequately reach out into the End-User's Application Areas.

The S&E User Community wants state-of-the-art hardware, software, telecommunications, and support services provided on a turnkey basis, at a

reasonable price. They want a state-of-the-art Multi-Level Distributed Data Processing System, which will met their ADP Processing Requirements. They want sufficient centralized and sufficient decentralized computer power to provide excellent response times for interactive applications and minimal turnaround times of an hour or two for all batch job processing requirements. They want easier vehicles to obtain complete ADP services in industry timeframes. And, they don't care how they get all the things they want, just as long as they get them in reasonable timeframes, with minimal paperwork and at a reasonable price. Currently, none of these conditions are being met. The S&E Central Computing Facility has obsolete and relatively slow large mainframe computers. The central computers do not have sufficient central memory to run large interactive and batch jobs. The central computers lack a Virtual Memory Operating System. The cost of the computer time is high relative to the cost of computer time at BMDSCOM. The existing mainframe hardware does not adequately support many software packages, that have large central memory requirements. Many available state-of-the-art Scientific and Engineering Codes will not run on the existing hardware, which is over two generations old. A modern central computing facility will alleviate these problems. And, a more diversified level of support from IMD would be appreciated by the S&E User Community.

The User Community wants IMD to take a leadership role in providing the automation support required by all elements of MICOM. If IMD aggressively pursues becoming the focal point for the automation needs of the Command, dramatic improvements in the S&E Computing Environments can be achieved. But, IMD cannot perform its mission without a high level of cooperation from the major MICOM organizations.

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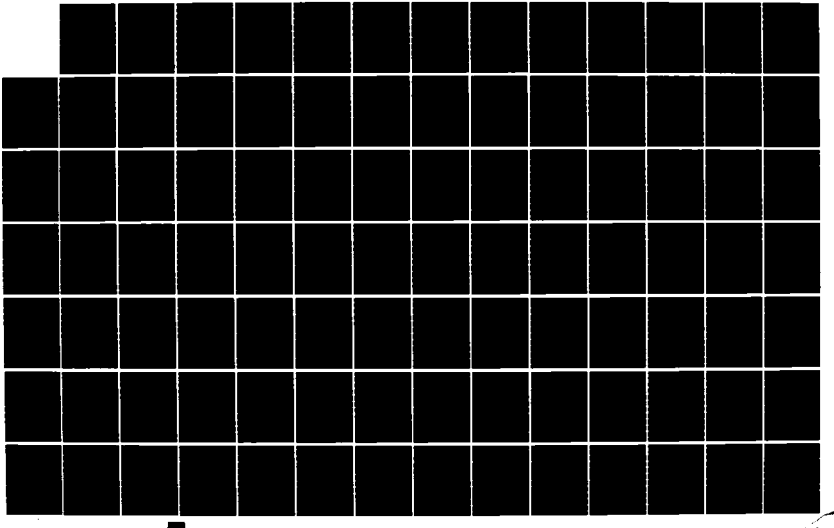
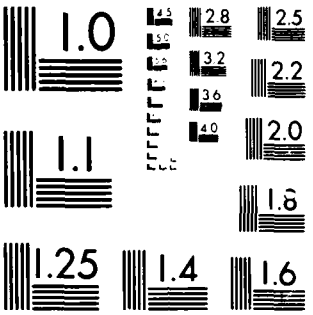




MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
ANALYSIS OF THE SIZE OF THE USER COMMUNITY
BY PROJECT OFFICE, FUNCTIONAL DIRECTORATES AND TMDE
ORGANIZATIONAL QUESTIONNAIRE 4-1 4-2 4-3 4-7

HEADORGCD

AMCPM	1A41	906	1A42	205	1A43	65	1A47	0
	1B41	81	1B42	31	1B43	17	1B47	0
	1C41	72	1C42	49	1C43	10	1C47	0
	1T41	1059	1T42	285	1T43	92	1T47	0
	2A41	990	2A42	417	2A43	141	2A47	26
	2B41	87	2B42	47	2B43	20	2B47	15
	2C41	63	2C42	44	2C43	10	2C47	0
	2T41	1140	2T42	508	2T43	171	2T47	41
	3A41	1011	3A42	564	3A43	182	3A47	37
	3B41	99	3B42	61	3B43	21	3B47	16
	3C41	40	3C42	34	3C43	5	3C47	0
	3T41	1150	3T42	659	3T43	208	3T47	53
AMSMI	1A41	1814	1A42	874	1A43	602	1A47	6
	1B41	28	1B42	11	1B43	3	1B47	0
	1C41	293	1C42	160	1C43	136	1C47	3
	1T41	2135	1T42	1045	1T43	741	1T47	9
	2A41	1978	2A42	1334	2A43	660	2A47	43
	2B41	29	2B42	16	2B43	4	2B47	0
	2C41	303	2C42	182	2C43	151	2C47	8
	2T41	2310	2T42	1532	2T43	815	2T47	51
	3A41	2043	3A42	1499	3A43	805	3A47	108
	3B41	46	3B42	28	3B43	5	3B47	1
	3C41	289	3C42	192	3C43	180	3C47	13
	3T41	2378	3T42	1719	3T43	990	3T47	122
AMXTM	1A41	1058	1A42	945	1A43	637	1A47	0
	1B41	468	1B42	172	1B43	117	1B47	0
	1C41	50	1C42	50	1C43	35	1C47	0
	1T41	1576	1T42	1167	1T43	789	1T47	0
	2A41	1064	2A42	977	2A43	641	2A47	0
	2B41	408	2B42	178	2B43	117	2B47	0
	2C41	50	2C42	50	2C43	35	2C47	0
	2T41	1522	2T42	1205	2T43	793	2T47	0
	3A41	1075	3A42	987	3A43	643	3A47	0
	3B41	408	3B42	173	3B43	117	3B47	0
	3C41	50	3C42	50	3C43	35	3C47	0
	3T41	1533	3T42	1209	3T43	795	3T47	0
TOTAL	1A41	3778	1A42	2024	1A43	1304	1A47	6
	1B41	577	1B42	214	1B43	137	1B47	0
	1C41	415	1C42	259	1C43	181	1C47	3
	1T41	4770	1T42	2497	1T43	1622	1T47	9
	2A41	4032	2A42	2728	2A43	1442	2A47	69
	2B41	524	2B42	241	2B43	141	2B47	15
	2C41	416	2C42	276	2C43	196	2C47	8
	2T41	4972	2T42	3245	2T43	1779	2T47	92
	3A41	4129	3A42	3049	3A43	1630	3A47	145
	3B41	553	3B42	262	3B43	143	3B47	17
	3C41	379	3C42	276	3C43	220	3C47	13
	3T41	5061	3T42	3587	3T43	1993	3T47	175

LEGEND: XY41=# OF PEOPLE
XY42=# OF COMPUTER USERS
XY43=# OF S AND E USERS
XY47=# OF SUPERCOMPUTER USERS

Y=A-CIVILIAN
B-MILITARY
C-CONTRACTOR

X=1-CURRENT
2-NEAR TERM
3-LONG TERM

Figure 2-21 Size of the User Community

NICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
ANALYSIS OF THE SIZE OF THE USER COMMUNITY
ACROSS LEVELS OF COMPUTERS
BY PROJECT OFFICE, FUNCTIONAL DIRECTORATES AND TMDE
ORGANIZATIONAL QUESTIONNAIRE 4-4

		COLCODE4 A	B	C	D
HEADORGCD					
AMCPM	1A44	32	27	45	48
	1B44	15	0	17	1
	1C44	3	10	9	1
	1T44	50	37	71	50
	2A44	49	90	111	81
	2B44	16	16	20	0
	2C44	3	9	7	1
	2T44	68	115	138	82
	3A44	60	110	155	122
	3B44	17	16	21	3
	3C44	2	2	2	1
	3T44	79	128	178	126
AMSMI	1A44	222	394	441	113
	1B44	2	3	6	0
	1C44	31	91	76	3
	1T44	255	488	523	116
	2A44	411	415	595	178
	2B44	3	9	9	2
	2C44	24	119	92	3
	2T44	438	543	696	183
	3A44	455	499	653	220
	3B44	3	9	10	3
	3C44	19	134	95	3
	3T44	477	642	758	226
AMXTM	1A44	29	645	647	647
	1B44	4	106	122	108
	1C44	0	35	35	35
	1T44	33	786	804	790
	2A44	46	648	664	662
	2B44	7	106	126	111
	2C44	0	35	35	35
	2T44	53	789	825	808
	3A44	51	652	682	694
	3B44	7	106	124	117
	3C44	0	35	35	35
	3T44	58	793	841	846
TOTAL	1A44	283	1066	1133	808
	1B44	21	109	145	109
	1C44	34	136	120	39
	1T44	338	1311	1398	956
	2A44	506	1153	1370	921
	2B44	26	131	155	113
	2C44	27	163	134	39
	2T44	559	1447	1659	1073
	3A44	566	1261	1490	1036
	3B44	27	131	155	123
	3C44	21	171	132	39
	3T44	614	1563	1777	1198

LEGEND: A-MAINFRAME B-MINICOMPUTER C-MICROCOMPUTER D-WORD PROCESSING

Figure 2-22 Distribution of Users Across Levels of Computers

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
ANALYSIS OF THE SIZE OF THE USER COMMUNITY ACROSS MACHINES
BY PROJECT OFFICE, FUNCTIONAL DIRECTORATES AND TMDE
ORGANIZATIONAL QUESTIONNAIRE 4-8

		COLCODE8 I	J	K	L	M	N	R
HEADORGCD								
AMCPM	1A48	26	9	129	38	6	1	3
	1B48	2	0	26	16	3	1	0
	1C48	1	0	16	7	12	0	0
	1T48	29	9	171	61	21	2	3
	2A48	48	17	219	57	10	4	2
	2B48	2	0	27	19	3	2	0
	2C48	1	0	20	3	12	0	0
	2T48	51	17	266	79	25	6	2
	3A48	53	34	319	103	14	6	12
	3B48	2	1	82	20	3	1	2
	3C48	0	0	70	3	12	0	0
	3T48	55	35	471	126	29	7	14
AMSMI	1A48	221	25	384	12	8	7	.
	1B48	2	0	2	2	0	0	.
	1C48	30	3	59	3	0	0	.
	1T48	253	28	445	17	8	7	.
	2A48	177	45	792	17	8	0	.
	2B48	3	1	4	2	0	0	.
	2C48	20	6	67	1	0	0	.
	2T48	200	52	863	20	8	0	.
	3A48	208	70	879	31	8	0	.
	3B48	3	1	6	3	0	0	.
	3C48	17	11	90	3	0	0	.
	3T48	228	82	975	37	8	0	.
AMXTM	1A48	7	.	831	.	103	.	.
	1B48	2	.	146	.	16	.	.
	1C48	0	.	45	.	5	.	.
	1T48	9	.	1022	.	124	.	.
	2A48	10	.	828	.	103	.	.
	2B48	2	.	146	.	16	.	.
	2C48	0	.	45	.	5	.	.
	2T48	12	.	1019	.	124	.	.
	3A48	13	.	834	.	106	.	.
	3B48	2	.	146	.	16	.	.
	3C48	0	.	45	.	5	.	.
	3T48	15	.	1025	.	127	.	.
TOTAL	1A48	254	34	1344	50	117	8	3
	1B48	6	0	174	18	19	1	0
	1C48	31	3	120	10	17	0	0
	1T48	291	37	1638	78	153	9	3
	2A48	235	62	1839	74	121	4	2
	2B48	7	1	177	21	19	2	0
	2C48	21	6	132	4	17	0	0
	2T48	263	69	2148	99	157	6	2
	3A48	274	104	2032	134	128	6	12
	3B48	7	2	234	23	19	1	2
	3C48	17	11	205	6	17	0	0
	3T48	298	117	2471	163	164	7	14

LEGEND: I-MICOM IND USAGE CDC
J-MICOM OTHER ORGANIZATION'S USAGE
K-YOUR OWN ORGANIZATION
L-OUTSIDE CONTRACTOR USAGE
M-MICOM IND USAGE IBM
N-OWN HOME COMPUTER
R-ARPANET
(COMPUTER BASED MESSAGE SYSTEM)

Figure 2-23 Distribution of Users Across Various Organization's Machines

MICOM SCIENTFIC AND ENGINEERING COMPUTER REQUIREMENTS ANALYSIS
ANALYSIS OF MANPOWER STAFF REQUIREMENTS
EQUIVALENT MANYEARS BY ENGINEERING DISCIPLINE

ECD	ENGINEERING DISCIPLINE	CUR RENT	NEAR TERM	LONG TERM
1	AEROSPACE AND AERONAUTICAL ENGINEERING	99	101	113
3	CHEMICAL ENGINEERING	10	12	11
4	CIVIL ENGINEERING	1	1	1
5	COMPUTER SCIENCE	50	72	69
6	ELECTRICAL AND ELECTRONICS ENGINEERING	264	277	284
7	FIRE PROTECTION ENGINEERING	1	1	1
9	HUMAN FACTORS ENGINEERING	7	10	12
10	INDUSTRIAL ENGINEERING	62	83	94
11	MATERIAL SCIENCE ENGINEERING	13	14	14
12	MECHANICAL ENGINEERING	131	141	151
13	MEDICAL ENGINEERING	1	1	1
14	NUCLEAR ENGINEERING	5	5	5
16	STRUCTURAL ENGINEERING	10	11	12
18	GENERAL ENGINEERING	220	237	241
19	LOGISTICS ENGINEERING	106	149	150
20	DATABASE MANAGEMENT	14	14	19
21	UNIVERSAL TEST EQUIPMENT	12	15	16
22	PROGRAM ANALYSIS	4	3	3
23	OPERATIONS RESEARCH ANALYSIS-COST ANALY	1	0	0
24	LASER MODELING	19	21	26
25	LASER PROPAGATION	1	1	1
26	PROJECT MANAGMENT RISK ANALYSIS	11	16	16
27	PHYSICS	23	23	23
28	ORSA SUPPORT-METROLOGY	1	1	1
29	MATH & STATISTICAL ANALYSIS	4	4	0
30	BUDGET AND ACCOUNTING	2	2	4
31	ELECTRONICS ENGINEERING	2	2	2
32	WEAPON SYSTEMS ANALYSIS	4	4	4
33	CONFIGURATION MANAGEMENT	2	2	2
34	LOGISTICS MANAGEMENT	2	2	2
35	COST ANALYSIS AND BUDGETING	1	1	1
36	ELECTRO-OPTICAL ANALYSIS	40	40	40
37	RADAR SPECIALIST	2	0	0
38	OPTICAL ENGINEERING	1	1	1
39	CHEMISTRY	4	4	4
TOTAL		1130	1271	1324

Figure 2-24 Manpower Staff Requirements by Engineering Area

MICOM SCIENTIFIC AND ENGINEERING COMPUTER REQUIREMENTS ANALYSIS
ENGINEERING MANPOWER STAFF REQUIREMENTS
EQUIVALENT MANYEARS BY MACARS SPECIALTY AREA

AREA CODE	MACARS SPECIALTY AREA	CURRENT	NEAR TERM	LONG TERM
1	AUTOMATIC TEST EQUIPMENT	23	24	36
2	CHEMISTRY	3	7	17
3	COMMAND AND CONTROL COMMUNICAT	9	16	22
4	COMPUTERS	47	76	105
5	CONFIGURATION MANAGEMENT	57	66	79
6	COST AND SCHEDULE ANALYSIS	80	86	109
7	ELECTRO-MAGNETIC RADIATION	4	3	4
8	ELECTRONIC COMPONENTS	19	19	27
9	FIRE CONTROL	9	7	10
10	GROUND SUPPORT EQUIPMENT	25	26	29
11	GUIDANCE AND CONTROL	26	24	26
12	HUMAN FACTOR ENGINEERING	7	9	2
13	INDUSTRIAL/MANAGEMENT ENGINEER	86	99	110
14	LASERS	5	2	3
15	MATERIALS	12	14	17
16	MATHEMATICS	39	42	50
17	METROLOGY	5	5	5
18	MISSILE DYNAMICS	13	13	16
19	NUCLEAR EFFECTS	3	4	5
20	OPERATIONS RESEARCH	32	91	41
21	OPTICS	4	1	2
22	PARTICAL BEAM	0	1	2
23	PRODUCT ASSURANCE	102	107	116
24	PROPULSION	24	25	24
25	RADAR	7	9	11
26	RISK ANALYSIS	9	11	13
27	SAFETY ENGINEERING AND MANAGEM	6	8	10
28	SEEKERS	23	21	18
29	SYSTEMS DESIGN AND DEVELOPEMEN	47	42	50
30	SYSTEMS SIMULATION	11	15	20
31	SYSTEMS	15	19	27
32	TARGETS	2	3	4
33	TELEMETRY	4	8	6
34	TEST AND EVALUATION	36	47	48
35	FACILITIES MANAGEMENT	10	16	21
36	INSTRUMENTATION	7	11	14
37	INFARED AND ELECTRO-OPTICAL SE	9	7	5
38	STRUCTURES	10	11	9
39	ADMINISTRATIVE SUPPORT FOR ENG	1	1	1
40	PUBLICATION PREPARATION	2	2	0
41	ELECTRICAL EQUIPMENT	4	4	4
42	WARHEAD ENGINEERING	1	0	0
TOTAL		838	1002	1118

Figure 2-25 Manpower Staff Requirements by MACARS Specialty Area

2.2 A Brief Investigation of the Past

This section attempts to shed some light on what has happened, in the Past, at MICOM. Section 2.2.1 provides an analysis and commentary on historic ADPE procurements. Section 2.2.2 provides a review of the level of support provided, as it relates to the S&E Computing Center and its Users. And, Section 2.2.3 provides an analysis of the workload on the S&E Central Computing Facility over the past few years.

This information provides a basic understanding of how the S&E Computing Environment has evolved at MICOM. This information was used, along with other information developed during the study, to formulate a definition of the problem, and, to develop some of the requirements.

2.2.1 ADPE Historic Procurement Analysis

The DARCOM ADPE Inventory Report revealed that MICOM has spent a little over 33 million dollars on ADPE since 1960. In the years 1960-1969, a little over 1.2 million dollars was spent on ADPE. During the years, 1970-1979, the expenditures were about 13.3 million dollars. During the years 1980-1985, the expenditures were about 16.6 million. Another 2 million dollars was earmarked for purchases during 1986 though 1988. Another 756 thousand dollars was aggregated from records with missing date information. An estimated 7.1 million dollars was spent on ADPE leasing arrangements. All of these dollars add up to roughly about 40 million. Of this amount, only about 4 to 6 million has been spent on the S&E Central Computing Facility for hardware purchases; and, another 600 thousand has been spent on the leasing of certain pieces of equipment. About 8 to 10 million, has been spent on the Business Central Computing Facility; and, the remaining 24 to 28 million has been spent on remotely distributed computing facilities. The historic data

clearly shows that sufficient funds have not been spent in maintaining the Central Computing Facilities in a state-of-the-art fashion.

Figure 2-26, which is a cost aggregation by generic equipment type, shows that: 38% of the total purchase costs went to Central Processor Units (CPU), 15% to Disk Devices (DSK), 7% to Magnetic Tape Devices (MAG), 9% to Plotters and Printers (GRA, PLT, PRT), 10% to terminals (TER) and another 21% is spent on a variety of other devices like: A/D converters, Controllers, Communications Devices, Card Readers, Interfaces, I/O Extenders, Optical Mark Readers, PC, Paper Tape, etc. These relative percentages can be used as useful planning tools for the next ten years, to help determine the optimal mix of centralized and decentralized computing power.

The S&E Central Computing Facility contains two large mainframe computers: a CDC 6600, which was installed in 1971; and, a CDC CYBER 74 computer, which was installed in 1978. Both machines have the same basic computer systems architecture. Both CPU processors are rated at about 3 MIPS. Both machines are technically obsolete and need to be replaced as soon as possible with a state-of-the-art system. The problem is that, by the time a new computer system is conceived, planned and budgeted for, approved, procured, and installed and tested (a process that can take up to 5 years), the system is well on its way to being, or already is, technically obsolete. The MICOM ADP Procurement Process must be cut down to a twelve to eighteen month process at a maximum; or, when new computer hardware is acquired it must be top-of-the-line technically, in order to preserve its technical useful life.

If the problems in the procurement process can be solved, the User Community will greatly benefit from higher quality ADP Equipment Acquisitions

over the next ten years. Obtaining longer system life cycle system approvals, with planned periodic improvements to include complete replacement, if necessary; would streamline ADP system acquisition procedures. A large part of MICOM's problems with a poor Scientific and Engineering Computing Environment can be directly attributed to the arduous ADP Approval and Procurement Process. Improvements can be made, but they will not be made overnight.

NICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COST DISTRIBUTION FOR PURCHASED EQUIPMENT INSTALLED
DURING THE PERIOD INDICATED (DETERMINED BY INSTALLATION DATE)

		INSTALLYEAR 50	60	70	80	TOTAL
GENCODE						
???	DOLLARS	.	.	.	19,220	19,220
	COUNT	.	.	.	8	8
A/D	DOLLARS	.	.	103,890	18,202	122,092
	COUNT	.	.	28	5	33
CNL	DOLLARS	.	48,625	497,529	332,876	879,030
	COUNT	.	1	66	36	103
CNT	DOLLARS	.	.	.	45,850	45,850
	COUNT	.	.	.	1	1
COM	DOLLARS	.	.	37,004	326,334	363,338
	COUNT	.	.	11	7	18
CPU	DOLLARS	.	719,496	5,202,678	6,542,784	12,464,958
	COUNT	.	6	142	133	281
CRD	DOLLARS	17,623	120,254	255,078	327,440	720,395
	COUNT	8	36	51	32	127
CTL	DOLLARS	.	.	14,646	.	14,646
	COUNT	.	.	1	.	1
DSK	DOLLARS	.	.	1,680,101	3,438,439	5,118,540
	COUNT	.	.	152	239	391
GRA	DOLLARS	.	.	.	8,890	8,890
	COUNT	.	.	.	1	1
INT	DOLLARS	.	.	7,968	24,928	32,896
	COUNT	.	.	9	16	25
IOE	DOLLARS	.	.	21,806	21,040	42,846
	COUNT	.	.	6	3	9
MAG	DOLLARS	.	186,400	1,466,527	724,343	2,377,270
	COUNT	.	9	118	49	176
OMR	DOLLARS	.	.	3,290	.	3,290
	COUNT	.	.	1	.	1
OTH	DOLLARS	12,807	97,970	3,126,237	1,437,504	4,674,518
	COUNT	6	12	206	118	342
PC	DOLLARS	.	.	.	20,000	20,000
	COUNT	.	.	.	8	8
PLT	DOLLARS	.	.	210,538	229,111	439,649
	COUNT	.	.	56	59	115
PRT	DOLLARS	.	28,550	1,104,509	1,378,749	2,511,808
	COUNT	.	2	155	320	477
PTP	DOLLARS	.	18,200	71,717	7,007	96,924
	COUNT	.	1	30	9	40
PTR	DOLLARS	.	.	2,300	.	2,300
	COUNT	.	.	1	.	1
TER	DOLLARS	.	.	1,380,886	1,865,956	3,246,842
	COUNT	.	.	346	1059	1405
TOTAL	DOLLARS	30,430	1,219,495	15,186,704	16,768,673	33,205,302

Figure 2-26 Historic Cost Distribution by Equipment Type

2.2.2 Level of Support

During the 1971 through 1980 timeframe, the level of ADP Support has, in the opinion of the User Community, been inadequate to meet the needs of the End-Users. The Central mainframe computers have not been replaced or augmented frequently enough to prohibit system workload saturation problems. The NOS/BE Operating System was initially designed as a "Batch" mode system, with punched card inputs. The interactive access capability was added as an after-thought; and INTERCOM has never been able to comfortably support more than about 60 MICOM Users at the same time without causing noticeable system degradation in response time. Terminals, printers, RJE workstations, graphics devices, etc., have not been readily provided to meet the User's demand for such devices. So, the Users have been forced to go out and procure their own equipment. This has made the Users comment that IMD does not function as the support and services organization that it is supposed to be. The CANNOT DO attitude of IMD has forced the User Community to seek out ways to obtain their own ADP support. Significant hardware, software and manpower support has been acquired through the procurement process at the price of lack of standardization, and lack of compatibility and transportability of End-User's applications across hardware.

The Command uses such an enormous variety of computer hardware and software packages from hundreds of different vendors, that it is extremely difficult for IMD to provide adequate support to the Users, without a significant increase in the number of in-house staff and an increased utilization of contractor provided services. In the past, the Scientific and Engineering support staff numbered over fifty individuals; now, the number has decreased to about thirty-five individuals. In the past, when there were only a few hundred S&E Computer Users, the level of support was excellent, because

there was adequate staff available to do the required programming work. But, as the size of the User Community grew rapidly, the number of support staff at IMD decreased. The net result was that the level of support diminished, as the demand for services grew and the number of staff providing the services shrank. Also, as the number of S&E Computer Users grew, sufficient mainframe computing power was not available, at a low cost, for their use. The net result is that millions of dollars have been spent on the acquisition of more hardware of less capability, than was really needed to adequately support the End-User's Processing Requirements. But, the "within $300,000" procurement threshold was facilitated. Now, hundreds of computers exist on the Arsenal; and, still, the S&E Workload is not being met in a timely fashion. The S&E mainframes are under utilized, because many large User applications cannot even be run on the old machines (because of the slow processor speed and lack of sufficient central memory), and, because of the high cost for the computer resources. The User's minicomputers and microcomputers have picked up some of the workload, but cannot accept much more future workload because of system saturation problems. So, the Users have turned to outside timesharing services for help and have found cheaper sources of mainframe computing power; and, they plan on purchasing more computers.

In the Past, the level of support provided by IMD, has not attempted to address the TOTAL REQUIREMENTS. The available staff simply has tried their best to support the User Community, within the limits of their capabilities. But, the demand for support services has greatly exceeded the resources available to provide the level of support required. IMD has had to turn away significant amounts of work, either because the S&E computers were not appropriate for the jobs or programming staff was not available to do the

coding work. After the Users have been refused service a few times, they tend not to even bother to check, if the situation on available resources has changed at a later date. This situation has contributed both to the decline of the utilization of the S&E Central Computing Facility and eventually to the decline in the use of IMD provided people-time services.

The User Community wants to see an improvement in the level of support that IMD provides. They would like to be kept informed, about the plans for satisfying the User's needs, regarding what will be supported, when, why and how; and, most importantly, at what price. In the Past, the Users have not been kept well informed regarding these issues. Therefore, the Users are skeptical about IMD's intentions. The image of IMD's level of support will improve, if IMD makes an aggressive move towards addressing the TOTAL S&E Requirements and does something tangible like replacing the S&E Mainframes, as soon as possible.

2.2.3 Historic Workload Analysis

IMD provided some very useful historic S&E Computing Center workload information regarding the use of the CDC 6600 and CYBER 74 machines from fiscal year '78 through the month of June 1985. A database was developed which contained monthly utilization statistics on the S&E Central Computing Facility mainframes. The database contained the following information:

CP SECONDS	- Central Processor Computer Time in Seconds
CP-RT SECONDS	- Central Processor Real Time Seconds
IO SECONDS	- Input/Output Time in Seconds
CM UNITS	- Core Memory Units in Kiloword Seconds (KWS)
ECS UNITS	- Extended Core Storage Units in KWS
CARDS READ	- # Cards Read
WORDS INPUT	- # Words Input
CARDS PUNCHED	- # Cards Punched
WORDS PUNCHED	- # Words Punched
LINES PRINTED	- # Lines Printed
WORDS PRINTED	- # Words Printed
TAPES REQUESTED	- # Tapes Requested
ICOM CONNECT SECONDS	- Intercom Interactive Terminal Connect Seconds
DDS CONNECT SECONDS	- DDS Console Connect Seconds
BATCH JOBS	- # Batch Jobs by Priority 1 to 7
TOTAL PP UNITS	- # Total Peripheral Processor Units

This monthly data was aggregated to produce the statistics and graphs used for this historic workload analysis. Unfortunately, this workload analysis deals only with the S&E Central Computing Facility, due to the fact that other MICOM organizations could not readily provide similar workload statistics for their remote computing centers.

Figures 2-27 to 2-38 are graphical representations of the S&E Computing Center workload, which were developed by fiscal year from the system monthly accounting summaries that were provided by IMD. During the period fiscal year '78 through June 1985, the Central Computing Facility Mainframes provided: 15,895 hours of Central Processor CPU time, 522 hours of Real-time CPU time, 21,254 hours of Input/Output Channel time, 2,457 million Core Memory Units

(KWS), 76.86 million Extended Core Memory Units (KWS); and, read 42.93 million input cards, punched 3.6 million cards, printed 1,315 million lines of output, processed 238,706 magnetic tapes, provided 241,340 hours of interactive connect time, provided 13,543 hours of Real-Time DDS terminal connect time and processed 901,391 batch jobs.

Figure 2-27 shows that a peak number of 3,018 CPU hours were consumed in FY 79. This peak was about a 57% increase over the FY 78 figure of 1,919 CPU hours. The number of CPU hours consumed, during the next few years, dropped from 2,270 in FY 80 to 2,056 in FY 81 to 1,609 in FY 82. A 54% increase in the CPU workload happened in FY 83, as the CPU hours jumped to 2,472. The gains were lost again in FY 84, as the CPU hours dropped to 1,619. The FY 85 hours through June amounted to a mediocre 932, and may reach only about 1,200 for the whole fiscal year.

Figure 2-28 shows a dramatic 118% growth in the number of Real-Time CPU hours consumed between FY 78 and FY 79. After the CYBER 74 was installed in 1978, the CDC 6600 became more or less dedicated to processing Real-Time Workload, and the CYBER 74 picked up most of the Batch Workload and all of the Interactive Workload. In FY 80, the Real-Time CPU hours dropped to only 40, then increased steadily until the FY 83 peak of 93 hours. The hours dropped to 75 in FY 84, but are expected to approach 90 for the full FY 85 period. Most of the Real-Time workload is now processed on the minicomputers in the laboratories and test cells that are scattered throughout the Arsenal.

Figure 2-29 shows a peak workload of 5,259 Input/Output (I/O) Channel hours in FY 78. This was followed by a dramatic decline, over the FY 79 to FY 82 period, to 1,813 I/O Channel hours. Then, there was a 34% increase to 2,438 I/O Channel hours in FY 83; followed by a substantial decline to an

estimated 1,000 I/O Channel hours for FY 85. According to the I/O Channel hours, the I/O workload has declined by over 81%, from FY 78 to FY 85.

Figure 2-30 shows a peak demand for 430 million Central Core Memory Units (in Kiloword Seconds (KWS)) during FY 83, which exceeded the previous high of 403 million in FY 79. Figure 2-31 shows a peak demand for 16.89 million Extended Core Memory Units in FY 81, which exceeded the previous high of 11.98 million in FY 79. Figure 2-30 shows a sustained decline in the demand for small-core requirements over the eight year period, with the exception of FY 83. Figure 2-31 shows a dramatic growth in the large-core requirements from FY 78 through FY 81; then a steady decline through FY 84, followed by a precipitous drop in FY 85. Based upon our interaction with the User Community, an interpretation of the situation was formulated. Basically, as the number of computers on the Arsenal grew, the small jobs that used to run on the mainframes were converted to run on the newer minicomputers. As more complicated high-core requirement programs were developed on the CDC mainframes, the demand for extended-core units increased. From FY 81 to FY 84, when most of the super minicomputers were introduced to the S&E Community, and the Users found out that the super minis could run the larger problems in Virtual Memory; most of the migration of large-core requirement programs from the CDC machines to the super minis took place. Substantial amounts of computing workload also migrated to competing government and various commercial timesharing operations over the past eight years.

Figure 2-32 shows that a peak number of 8.45 million cards were read in FY 78. It also shows a steady decline in the number of cards read during each fiscal year from '78 to '85, with the exception of the sharp increase during FY 83. The Users indicated that there are millions of lines of S&E Code, that

are stashed away in card cabinets and on magnetic tape throughout MICOM. Some of the programs are used every day, while others may be used only a few times a year. The decline in the number of cards read helps to support the observation that a substantial workload has migrated away from the Central Computing Facility, because many programs are stored on cards and people still use card decks to submit batch jobs.

Figure 2-33 shows that a peak number of 1.399 million cards were punched in FY 78. The decline in the annual volume of card punching activity is very evident. Many Users made back-up copies of their codes on punched cards, as they migrated their applications onto their own computers. In general, as the years passed, the S&E Community has become less interested in using the punched card as a medium of storing programs and data; and, the terminal keyboard has replaced punched cards as the primary mechanism for entering programs and data. But, people still feel that they need their program card decks, in case something happens to the copy on disk or tape.

Figure 2-34 shows that a peak number of 232 million lines were printed in FY 78. During FY 78 to FY 81, the average number of lines printed was 226 million. During FY 82 to FY 84, the average number of lines printed dropped to 120 million. Over the entire period from FY 78 to FY 85, the number of lines printed dropped from 232 million to an estimated 65 million, which represents a drop in the printing workload of 78%.

Figure 2-35 shows that a peak number of 39,701 tapes were processed in FY 80. During FY 78 to FY 81, an average of 37,764 tapes were processed each year. During FY 82 to FY 84, the average number of tapes processed dropped to 25,429. For FY 85, the number of tapes processed are estimated not to exceed

14,000. Roughly speaking, 60 to 70% of the tape processing workload has migrated from the Central Computing Facility over the last eight years.

Figure 2-36 shows that a peak number of 38,037 interactive connect hours were provided to the Users in FY 79. During FY 78 to FY 81, an average of 36,099 connect hours were consumed. During FY 82 to FY 84, the average number of connect hours used dropped to 27,318. The connect hours for FY 85 are estimated not to exceed 18,000. Roughly speaking, 50% of the interactive terminal connect hour workload has migrated from the Central Computing Facility onto the User's minis and micros.

Figure 2-37 shows a peak demand for Real-Time DDS terminal connect hours in FY 79. The 2,493 hours in FY 79 represent a 78% increase over the 1,403 in FY 78. Erratic demands for Real-time DDS terminal connect hours exist across the eight year period. Most of the Real-Time requirements have migrated to the DEC VAX, HP 1000 and SEL machines over the past six years.

Figure 2-38 shows that a peak number of batch jobs were processed in FY 79. The 150,042 jobs in FY 79 represent a 26% increase over the 118,611 batch jobs processed in FY 78. During the FY 78 to FY 81, the average number of batch jobs processed was 136,504. During FY 82 to FY 84, the average number of batch jobs processed dropped to 100,527. For FY 85, the number of batch jobs processed is estimated not to exceed 65,000. Roughly speaking, 57% of the batch processing workload has migrated away from the Central Computing Facility.

Figure 2-39 shows the distribution of computers installed at MICOM across calendar years, according to the data contained in the DARCOM ADPE Inventory. An analysis of the data shows that, between 1975 and 1979, 102 computers were

installed at MICOM; and that, between 1980 and 1984, 133 computers were installed at MICOM. In a ten year period, 235 computers were added to MICOM's computer inventory. The CDC CYBER 74 (a 3 MIP processor) mainframe was added in 1978, and a UNIVAC 1100/81 (a 3 MIP processor) and a UNIVAC 1100/71 or 72 (a 1.6 - 2.9 MIP processor) were added after 1980. The majority of the computers that have been added to the MICOM computer inventory are powerful minicomputers in the .3 to 4 MIPS processor range.

The Central Facility mainframes represent only 6 MIPS of computing power. The 281 computers in the DARCOM inventory, that are on the Arsenal, represent approximately 140.6 MIPS of computing power. The 441 computers identified during the survey represent approximately 205.3 MIPS of computing power. The estimated number of 722 computers represent approximately 345.9 MIPS of computing power, or an average of .479 MIPS per computer.

The CYBER 74 mainframe was saturated within fourteen months after it was installed. The S&E Community began purchasing very powerful minicomputers and microcomputers to handle the workload; and, has plans to continue to acquire many more computers to handle their workload. The S&E computing workload in 1971 was adequately handled by a CDC 6600 (3 MIP) machine. In 1979, the S&E workload saturated the 6 MIP Central Facility (CDC 6600 + CYBER 74). The workload migrated to hundreds of smaller computers and most of those minicomputers are now saturated; and, the Users want to replace their computers with faster minicomputers in the 5 to 10 MIP range. If inadequate computers continue to be acquired, no improvements will be made to the S&E Computing Environment at MICOM.

MICOM also continues to purchase supercomputer and large-mainframe computer time from a variety of sources. Computer time is purchased from NASA

Langley, Moffet Field, Lawerence Livermore Laboratories, White Sands and from many more sources, such as the larger universities that have large computers available. Cheap CDC computer time is purchased from BMDSCOM and BMDATC. Possibly as many as one-hundred different contractors, universities and other government agencies are providing MICOM with computer time. The computer time is provided both under direct timesharing arrangements, and as part of service contracts.

The TOTAL MICOM S&E Computing Workload has increased dramatically over the past fifteen years, and is still growing. MICOM continues to address the computing needs with improper and inadequate levels of computer hardware. Now is the time to design a network of mainframes to handle the needs of the S&E Community; and, later augment that system with a supercomputer capability. The total workload exists to justify the concept, the problem will be getting MICOM organizations to see the benefits of the concept and decide to cooperate (for a change) in satisfying their computing needs.

In 1971, the CDC 6600 mainframe was installed; and, within a year approximately one hundred individuals were utilizing the S&E Computing Center. During a ten year period, the number of S&E Center Computer Users grew to over 600 people. During 1978 to 1980, between 500 and 600 Users were generating a computing workload, which saturated the CDC 6600 and CYBER 74 mainframes. In gross average terms, each active User was using an average of between 4.27 and 11.34 hours of CPU time, submitting between 261 and 500 batch jobs per year, generating between 341 and 421 thousand lines of print each year, and using between 55 and 148 hours of connect time per year.

The data collected on the Organizational Level Questionnaires showed that

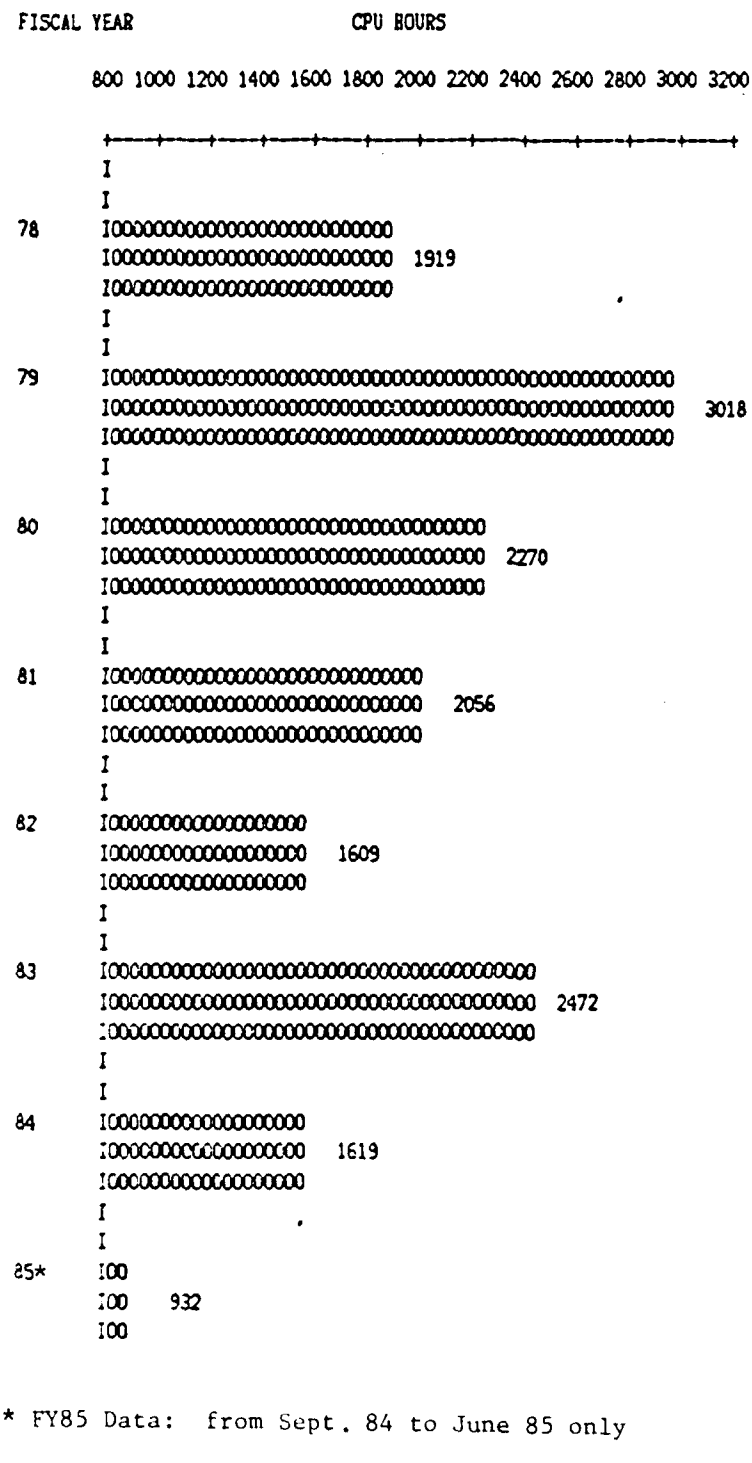
there are currently 1,622 S&E Users. ISI estimates that currently there are between 1,622 and 2,497 S&E Users. This shows that the User Community that currently exists has grown somewhere between 270% and 499%, or roughly three to five times, since 1979. This fact can be used to argue that the total MICOM S&E Computing Workload has also increased between 270% and 499%, if the 500 to 600 S&E Central Computing Facility Users represent a typical group of 500 to 600 S&E Users. ISI believes that this representation is reasonable because it represents a rather large sample of actual MICOM S&E Users (i.e., 31% to 37% of the 1,622).

The number of MICOM S&E Users is expected to reach a peak of 4000, during the next ten years. If one accepts the fact that a group of 500 to 600 Users generated the peak 1978-1980 workloads on the Central Mainframes, then simple extrapolation parameters of between 6.67 and 8.0 can be developed using the number of Users as a yardstick of measurement. Crude as this approach may be, it is actually quite reasonable. These parameters should be viewed as baseline parameters only, because the sophistication level of modern software packages will dramatically increase the demands for more CPU cycles and significantly larger amounts of central memory. In addition, the growing demands for interactive computing places an increasing demand for significantly faster central processor speeds, to maintain reasonable response times for the interactive Users.

The new Scientific and Engineering Computing Environment must be designed to handle the peak workload that will be generated by up to 4,000 S&E Users. Multiple mainframe computers will be required to handle the workload, along with access to a supercomputer.

NICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
STUDY OF S & E COMPUTER CENTER UTILIZATION

GRAPH OF TOTAL CPU HOURS BY FISCAL YEAR

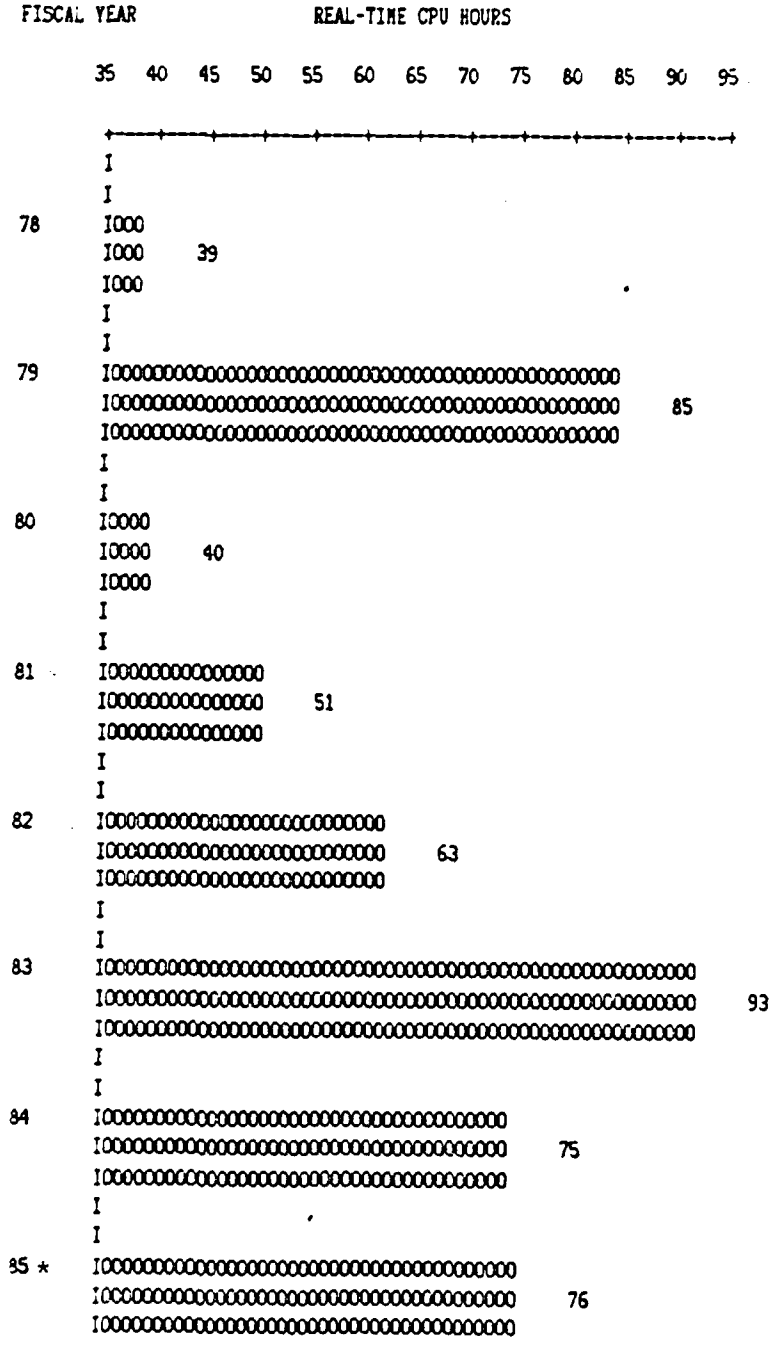


* FY85 Data: from Sept. 84 to June 85 only

Figure 2-27 Historic Workload-CPU Hours

NICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
STUDY OF S & E COMPUTER CENTER UTILIZATION

GRAPH OF TOTAL REAL TIME CPU HOURS BY FISCAL YEAR

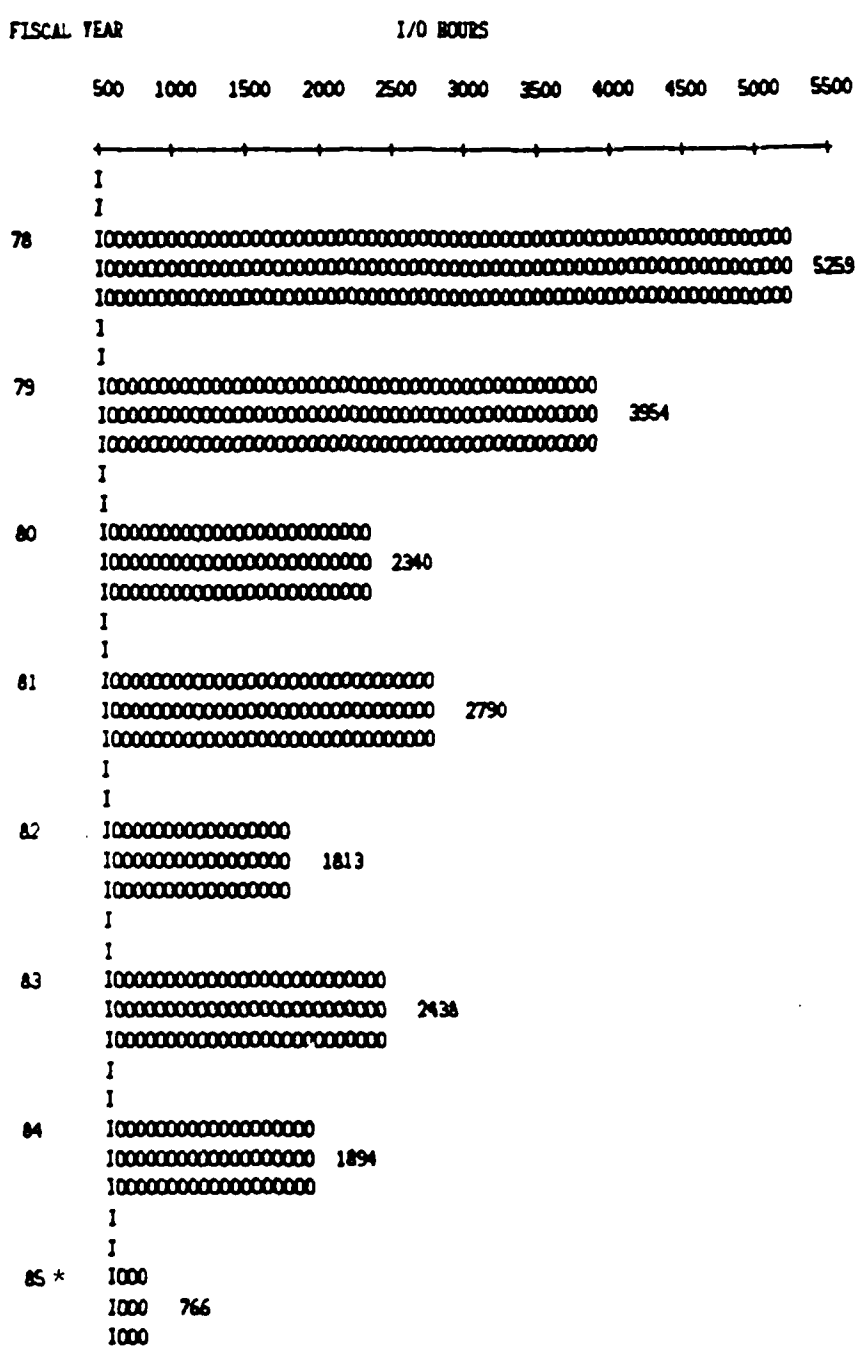


*FY85 Data: from Sept. 84 to June 85 only

Figure 2-28 Historic Workload-Real-Time Hours

NICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
STUDY OF S & E COMPUTER CENTER UTILIZATION

GRAPH OF INPUT/OUTPUT CHANNEL HOURS ACROSS FISCAL YEAR

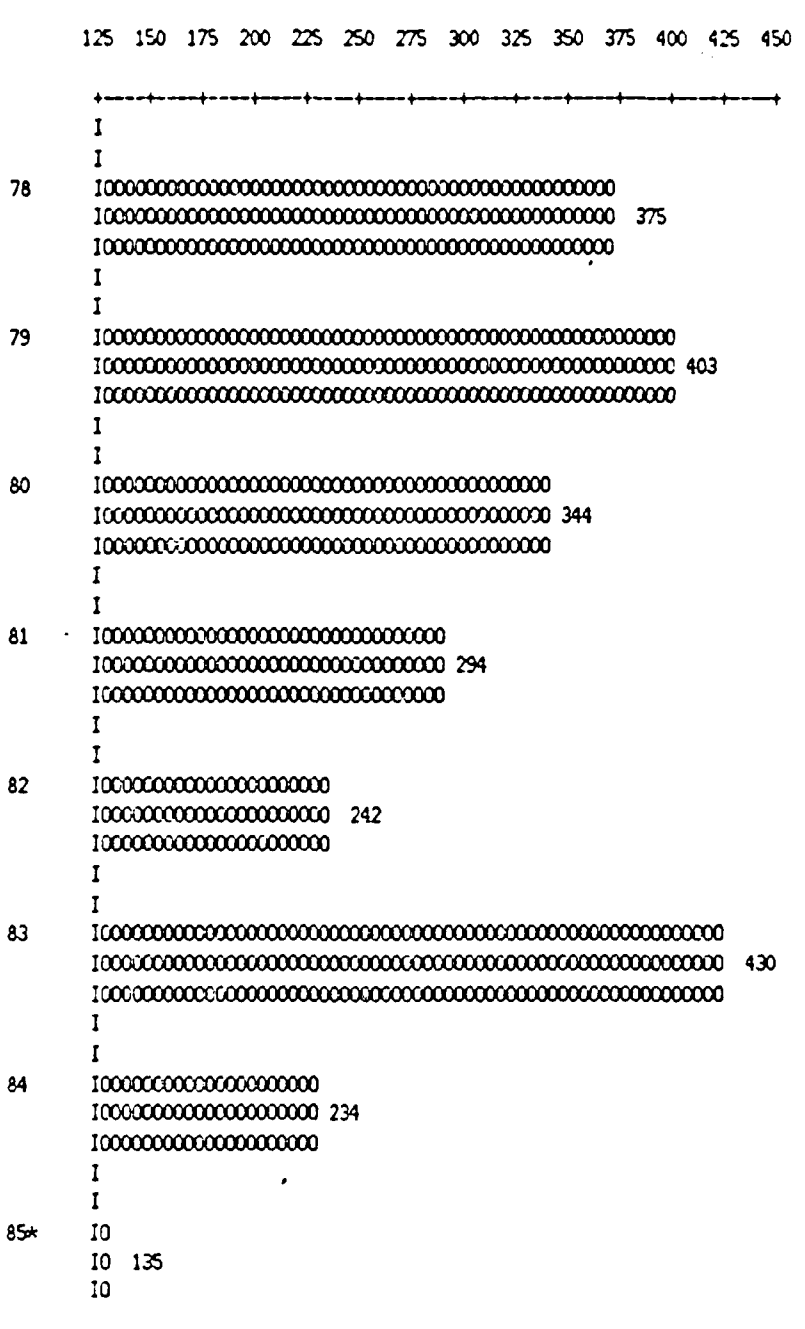


* FY85 Data: from Sept. 84 to June 85 only

Figure 2-29 Historic Workload-Input/Output Channel Hours

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
STUDY OF S & E COMPUTER CENTER UTILIZATION

GRAPH OF TOTAL CORE MEMORY UNITS (KWS) BY FISCAL YEAR

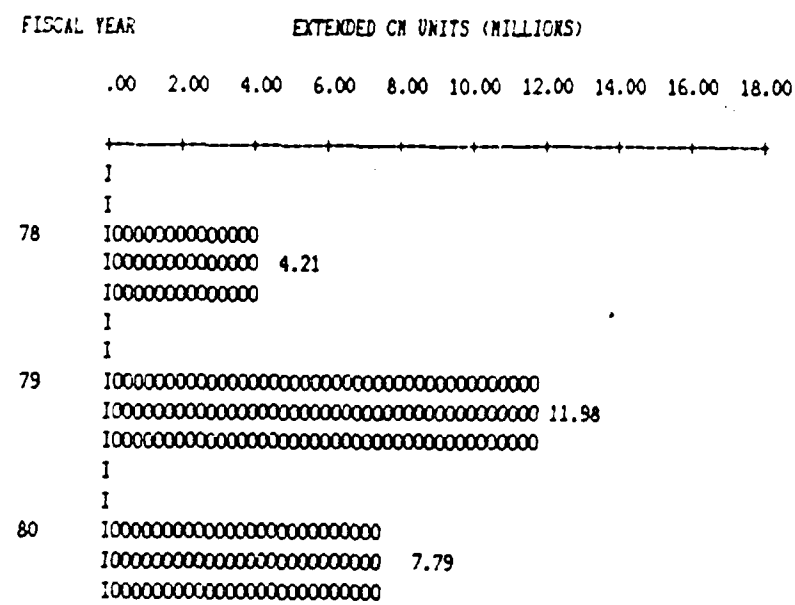


*FY85 Data: from Sept. 84 to June 85 only

Figure 2-30 Historic Workload-Central Core Memory Units (KWS)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
STUDY OF S & E COMPUTER CENTER UTILIZATION

GRAPH OF EXTENDED CORE MEMORY BY FISCAL YEAR

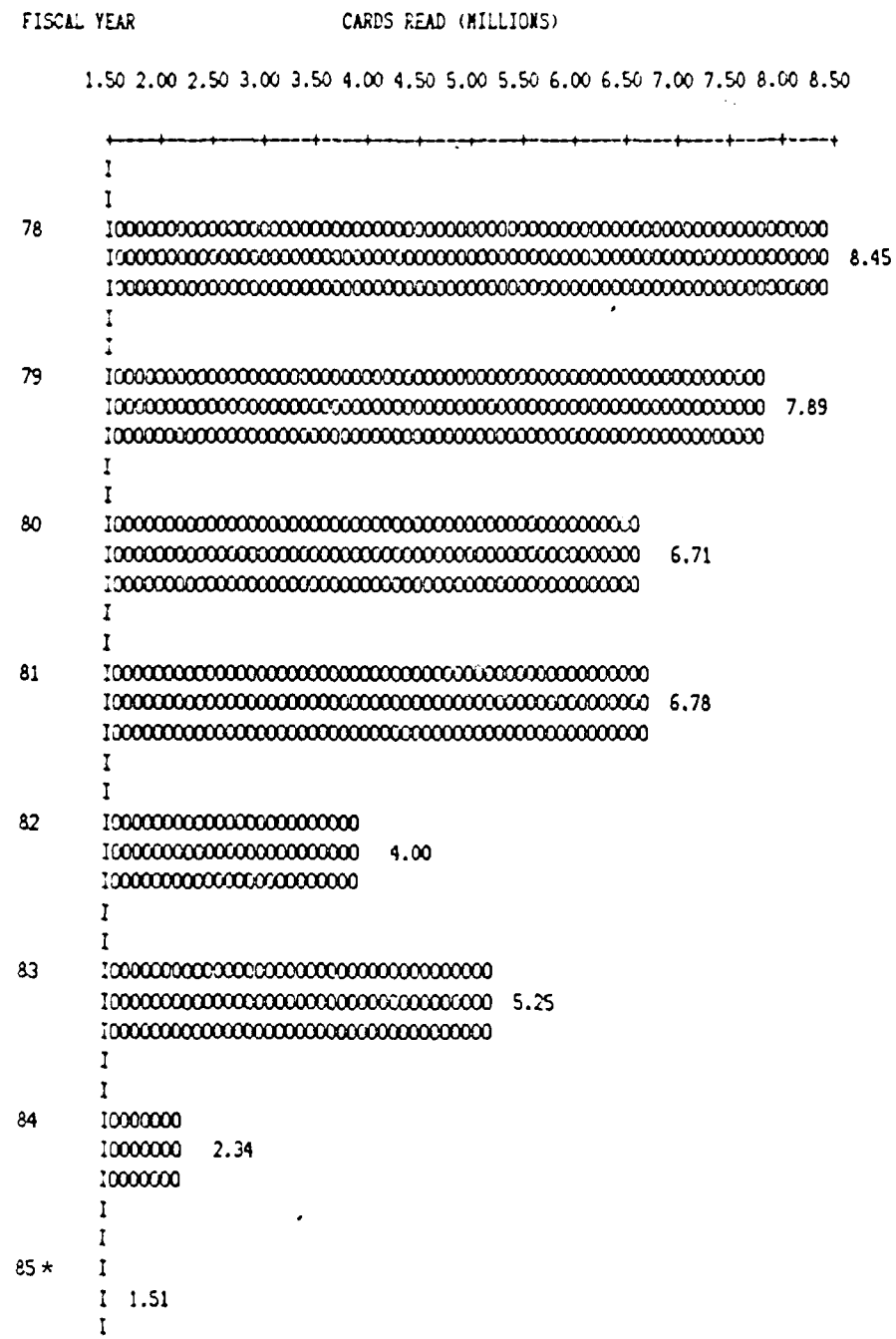


*FY85 Data: from Sept. 84 to June 85 only

Figure 2-31 Historic Workload-Extended Core Memory Units (KWS)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
STUDY OF S & E COMPUTER CENTER UTILIZATION

GRAPH OF # OF CARDS READ BY FISCAL YEAR

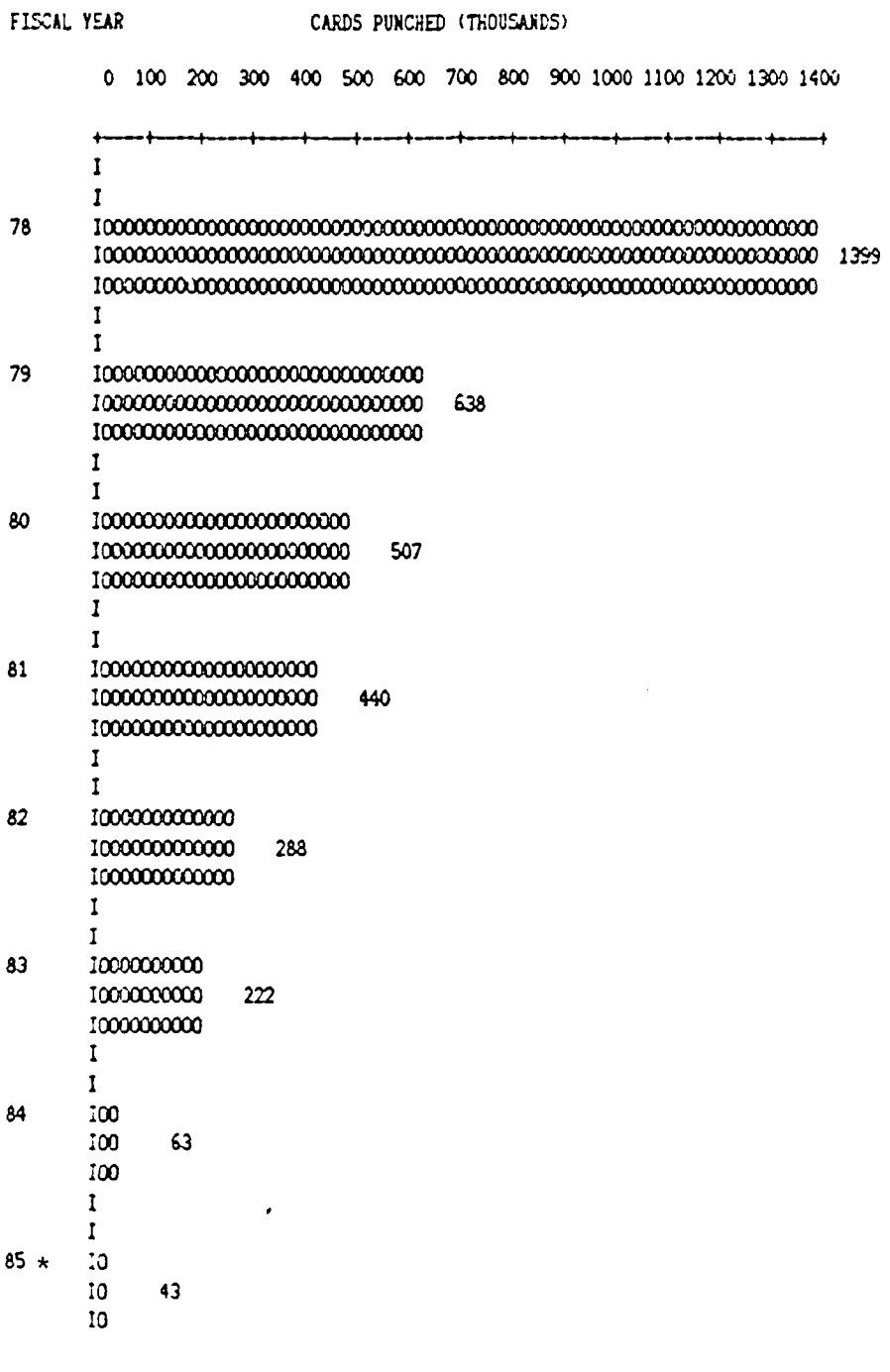


*FY85 Data: from Sept. 84 to June 85 only

Figure 2-32 Historic Workload-Cards Read

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
STUDY OF S & E COMPUTER CENTER UTILIZATION

GRAPH OF # OF CARDS PUNCHED BY FISCAL YEAR

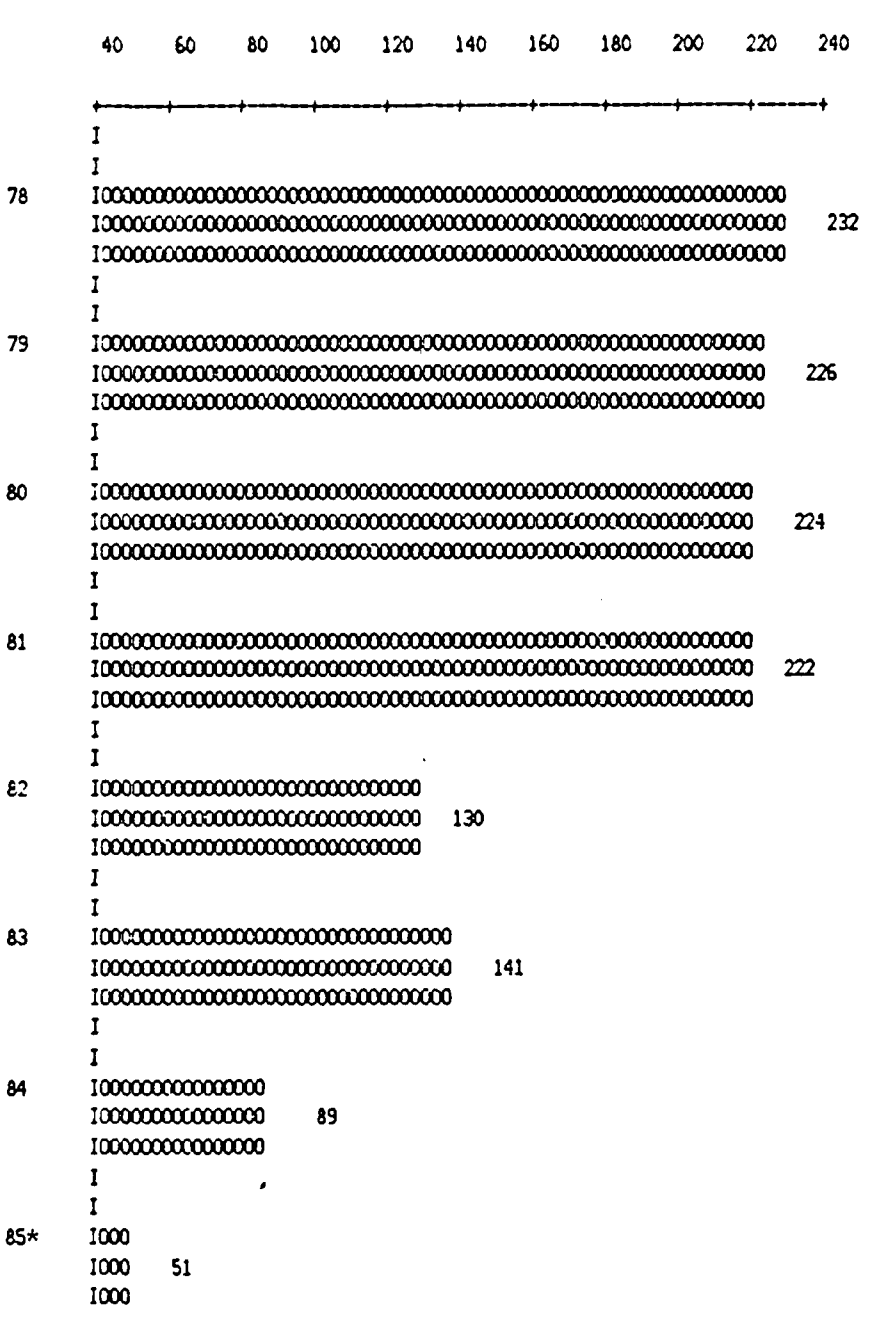


*FY 85 Data: from Sept. 84 to June 85 only

Figure 2-33 Historic Workload-Cards Punched

NICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
STUDY OF S & E COMPUTER CENTER UTILIZATION

GRAPH OF # OF LINES PRINTED BY FISCAL YEAR

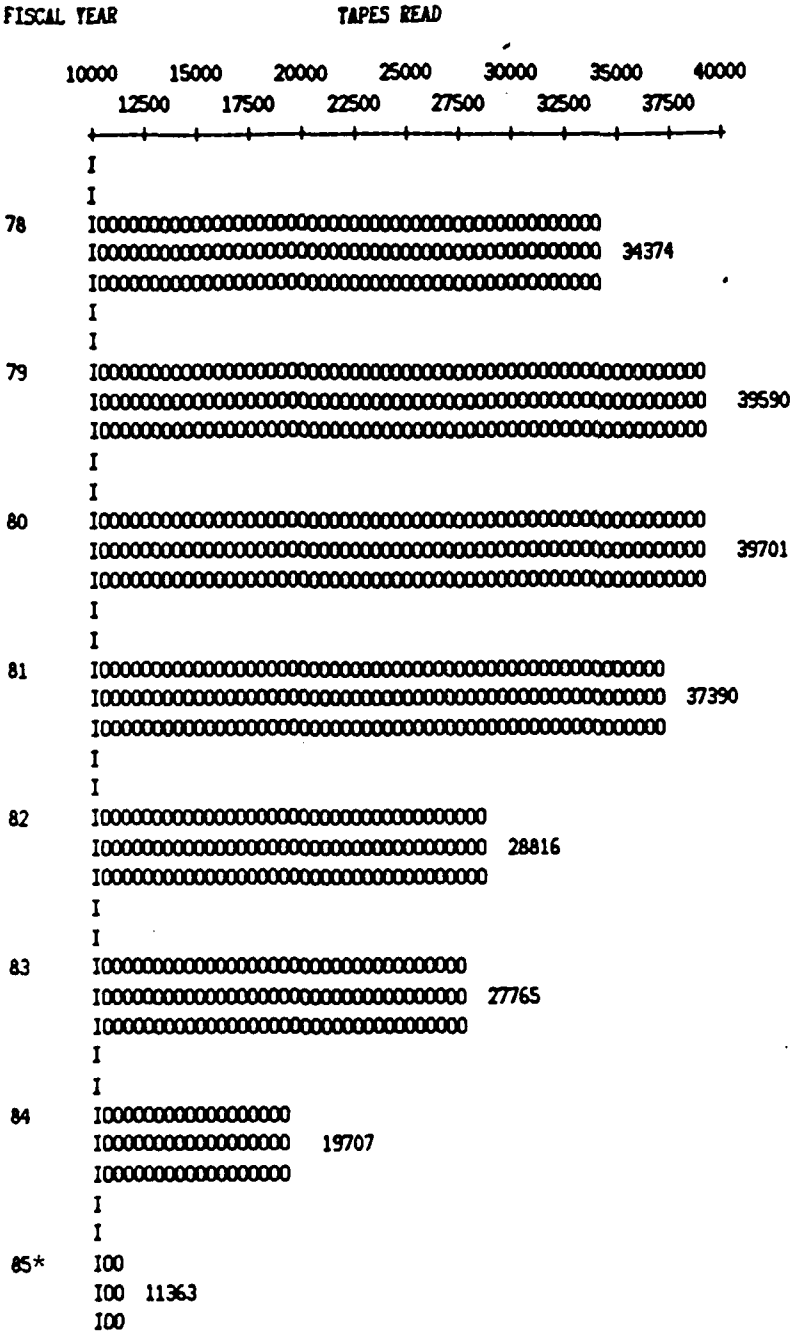


*FY85 Data: from Sept. 84 to June 85 only

Figure 2-34 Historic Workload-Lines Printed

NICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
STUDY OF S & E COMPUTER CENTER UTILIZATION

GRAPH OF # OF TAPES READ BY FISCAL YEAR

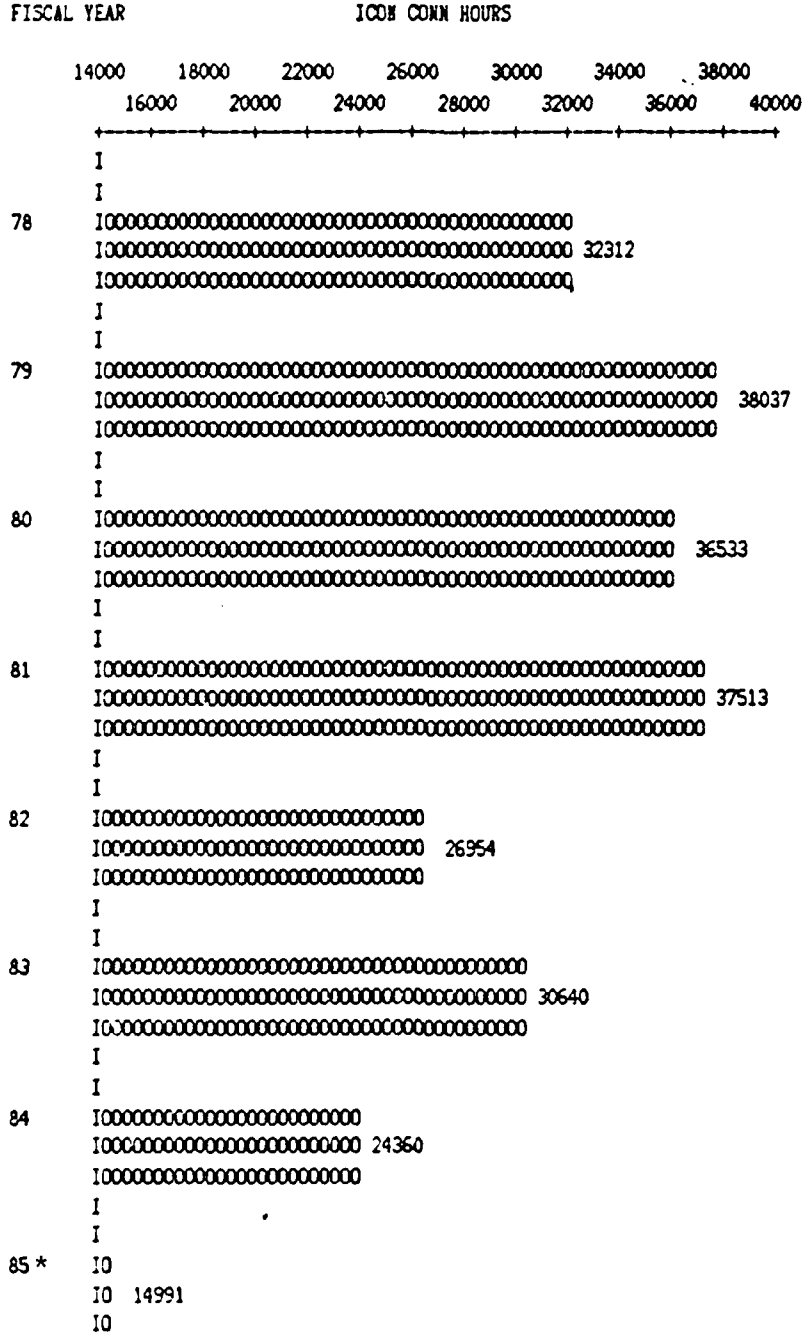


* FY85 Data from Sept. 84 to June 1985 only

Figure 2-35 Historic Workload-Tapes Read

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
STUDY OF S & E COMPUTER CENTER UTILIZATION

GRAPH OF ICOM CONNECT HOURS BY FISCAL YEAR

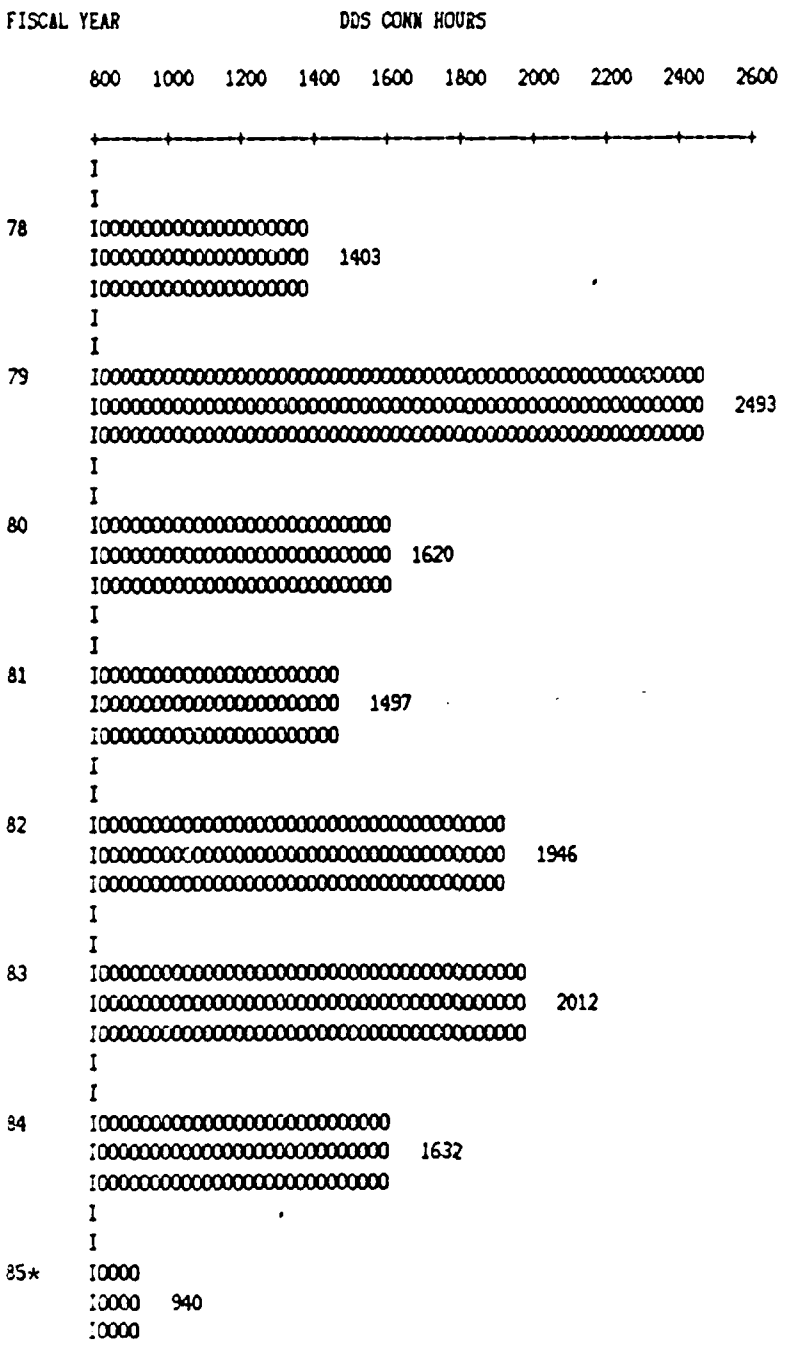


*FY85 Data: from Sept. 84 to June 85 only

Figure 2-36 Historic Workload-Interactive Connect Hours

NICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
STUDY OF S & E COMPUTER CENTER UTILIZATION

GRAPH OF DDS CONNECT HOURS BY FISCAL YEAR

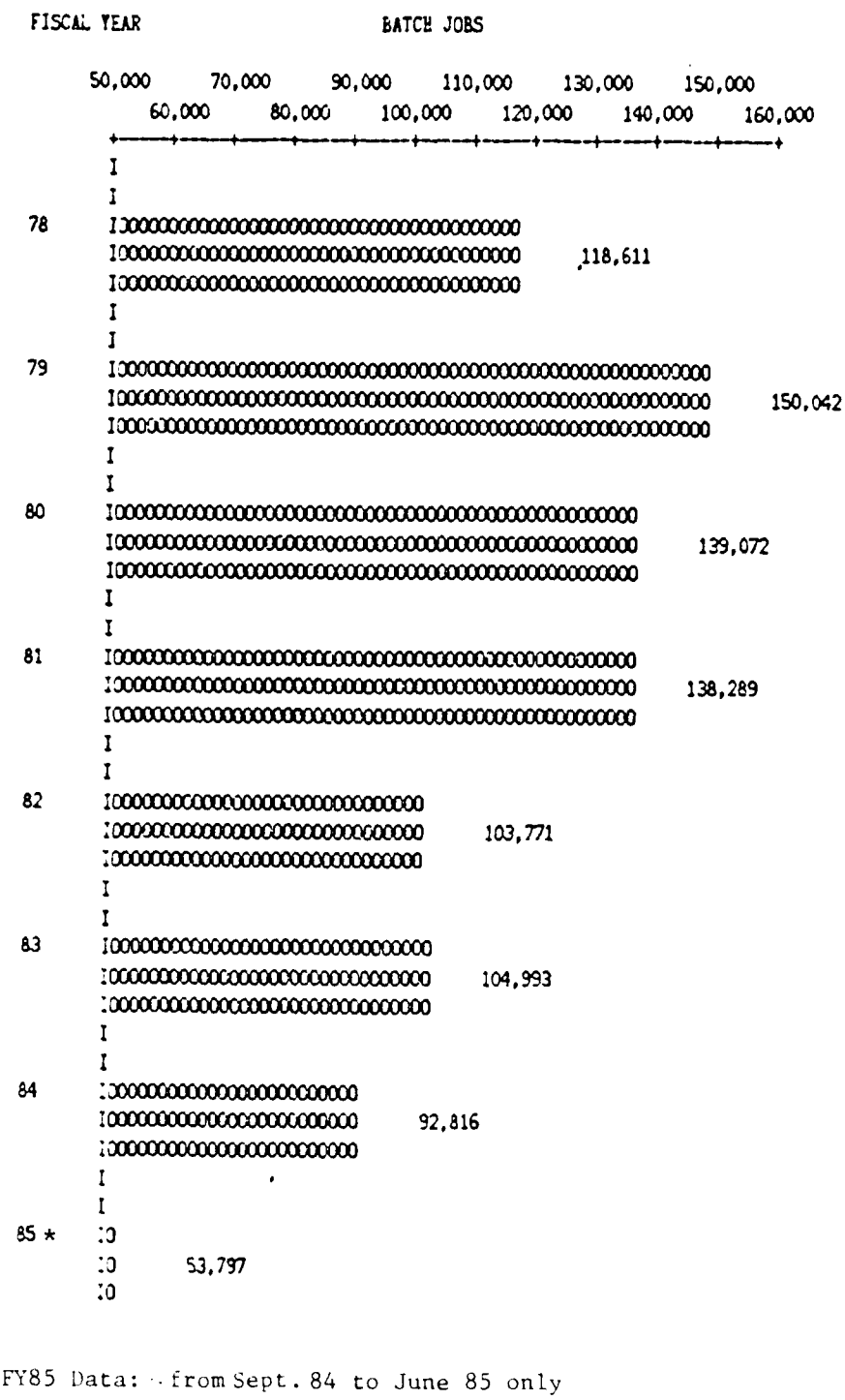


*FY85 Data: fromSept. 84 to June 85 only

Figure 2-37 Historic Workload-Real-Time DDS Terminal Connect Hours

NICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
STUDY OF S & E COMPUTER CENTER UTILIZATION

GRAPH OF # OF BATCH JOBS BY FISCAL YEAR



*FY85 Data: from Sept. 84 to June 85 only

Figure 2-38 Historic Workload-Number of Batch Jobs

NICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
DISTRIBUTION OF COMPUTERS INSTALLED ACROSS CALENDAR YEARS
BY HARDWARE MANUFACTURER, TYPE AND MODEL
FROM DARCOM ADPE INVENTORY REPORT

			INSTALLDATE																			
			60	62	64	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	TOT
HWMFF	HWTYPE	HWMOD																					
ADC	AD	4	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	AD4		.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
AMR	AM100		.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
APM	2		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	AA110	40B	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
ATA	800		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
CBM	2001		.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	6	.	.	.	.	7
	8032		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
CCC	DPD24		.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
CDC	160	A	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	6614		.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	74	18	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	CYBER	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
DAF	6024		.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
DEC	1123	AX	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
	LSI11		.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
		23	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
	PDP11		.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
		03	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	2
		10	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
		10E	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
		20	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
		23	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
		34	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2	1	.	1	.	.	7
		35	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
		40	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
		45	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
		55	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
		70	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	2
	PDP8E		.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	SM70C	BA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
	VAX11	780	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
	VX11	780	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	2
DGC	ECLSI	30	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	NOVA	312	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
	NOVA3	12	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
DTA	10076	104	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
		230	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
EAI	600		.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
FPS	120B		.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	3	.	.	.	6
	AP120	B	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
HCS	SLASH	6	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
HPC	125		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	.	9
	2100	A	.	.	.	.	.	.	1	.	1	.	1	1	2	.	.	.	.	.	.	.	6
	2100A		.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	2100C		.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	2
	2100S		.	.	.	.	.	.	.	.	3	.	3	.	.	.	.	.	.	.	.	.	6
	2108A		.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	4
	2111F		.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
	2112A		.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	2

Figure 2-39 Computers Added Across Years

NICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
DISTRIBUTION OF COMPUTERS INSTALLED ACROSS CALENDAR YEARS
BY HARDWARE MANUFACTURER, TYPE AND MODEL
FROM DARCOM ADPE INVENTORY REPORT

			INSTALLDATE																				
			60	62	64	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	TOT
HWMFF	HWTYPE	HWMOD																					
HPC	2113	E	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	2113A		.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	2
	2113E		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	2
	2114B		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2
	2116	B	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
		C	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	2117	F	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	2
	2117F		.	.	.	.	.	.	.	.	.	.	.	1	.	.	4	3	.	.	.	.	8
	2142	A	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	5
	2174A		.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	21MX		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
		E	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	21MXE		.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	3
	21MXR		.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	3251	4A	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	405X		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	45500	A	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
	5422B		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	54427	A	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	54451	B	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
	5934A		.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	85	A	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	2	.	.	3
	85A		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.	3
	9020	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	9100B		.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	9115	A	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	2
	9610A		.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	9820A		.	.	.	.	1	.	.	1	1	.	1	1	.	.	.	.	.	.	.	.	5
	9821A		.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	2
	9825	A	.	.	.	.	.	.	.	.	.	.	.	2	.	2	1	.	.	.	.	.	5
	9825A		.	.	.	.	.	.	.	.	.	1	.	1	1	2	1	.	.	.	.	.	6
	9825S		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
	9826	A	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	2
	9830	A	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	2
	9830A		.	.	.	.	.	.	.	.	4	8	6	1	.	.	.	.	.	.	.	.	19
	9835A		.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
	9836		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	9845	B	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3	.	.	6
		C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	2
		T	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2	.	.	.	3
	9845A		.	.	.	.	.	.	.	.	.	.	.	.	1	.	2	.	.	.	.	.	3
	9845B		.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	2
	9845T		.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	8	4	.	.	.	15
IBM	1401	C4	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	4341	M02	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	2
		M12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
	5010	57	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
		A12	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
		A16	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
		E48	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1

Figure 2-39 Computers Added Across Years (Cont'd)

NAVY SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
DISTRIBUTION OF COMPUTERS INSTALLED ACROSS CALENDAR YEARS
BY HARDWARE MANUFACTURER, TYPE AND MODEL
FROM DARCOM ADPE INVENTORY REPORT

			INSTALLDATE																				
			60	62	64	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	TOT
HWMFF	HWTYPE	HWMOD																					
IEL	DS286		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
	NDS	230	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
IMA	8080		.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
ITD	80		.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	.	.	.	.	.	7
	832		.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
ITE	7000	AS5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
		AS3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
		AS5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
MOT	M6800		.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	2
	M6809		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	2
NSR	H2		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
PKE	3220		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
	3230		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
	3242		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
	3252		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
PLX	25		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
RCS	TRS80		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
		12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
ROI	65		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
	AIM65		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
SEL	3277		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	4
TEK	1162		.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	4051		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
		A	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	3
	4054		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
		A	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
TEX	99.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
UNI	3032	96	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
VAR	620	I	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	77600	613	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
VEG	SYS 5		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	6
WAN	700		.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	700B		.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	7200		.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
TOTAL			2	1	1	1	1	3	7	4	12	14	21	18	17	20	26	40	37	28	23	5	281

Figure 2-39 Computers Added Across Years (Cont'd)

2.3 A Brief Look Into The Future

This section provides some information regarding the future. Section 2.3.1 provides information on the number of applications by organization. Section 2.3.2 provides additional information regarding the growth of the User Community. And, Section 2.3.3 provides some discussion regarding the advancement of technology.

This information provides a look into the future based upon: information gathered from the End-Users on the User Level Questionnaires; information gathered from the Organizational Level Questionnaires; and, interviews with representatives of the MICOM S&E Community. This information was provided as a contrast to the past. This information was used to help formulate a definition of the problem, and, to develop some of the requirements.

2.3.1 New Applications by Organizations

Data collected on the User Level Questionnaires, from 148 Users, revealed that there are substantial numbers of S&E Computer Applications that the Users work on, that currently exist and are planned for the future. The data showed that the 148 Users, who responded to the survey, worked on 610 different applications; that 1506 applications currently exist; that over the near-term 1745 applications will be developed; and, that 5145 applications will be developed over the long-term. In other words, a tremendous growth in the number of S&E Computer Programs is expected over the long-term. Figure 2-40 shows an aggregation by Engineering Area of the number of computer applications that the respondents work on, and their estimate of how many applications programs currently exist, and will be developed over the near-term and long-term. Figure 2-41 provides a breakdown of the data by Project

Management Offices (AMCPM), Functional Directorates (AMSMI) and TMDE (AMXTM).

Figure 2-40 shows that a high concentration of computer applications exists in the Aerospace and Aeronautical Engineering, Computer Science, Electrical and Electronics Engineering, and Operations Research-Cost Analysis Areas. It also shows a less dense concentration of applications in many other Engineering Areas. Figure 2-41 shows that most of the S&E Applications exist in the Functional Directorates across most of the Engineering Areas.

Figure 2-42 provides an estimate of the number of computer applications that exist in various MACARS Specialty Areas. It is organized by MICOM organizations that provided some User Level Questionnaires. The estimate was developed assuming that each MACARS Specialty Area, that was checked off by the User as being supported by computer applications, represented only one application. Although the number of applications may not be that accurate, Figure 2-42 clearly shows which organizations have concentrations of S&E Computer Applications. The data collected from only 148 Users established the fact that all MACARS Specialty Areas are supported by computer applications. It also pointed out that S&E Applications exist predominantly in the Functional Directorates, and that S&E Applications do exist in the Project Management Offices.

The study revealed that a strong growth in the number of S&E Computer Applications is anticipated over the next ten years. It also concluded that the expansion will take place predominantly in the Functional Directorates; but, growth in the S&E Area within the Project Management Offices should also be anticipated as the PMO shops become more computer oriented.

The data provided on the Organizational Level Questionnaires did not

identify all of the S&E Computer Applications that exist. Many individuals interviewed provided information on applications that they were familiar with. The information collected only scratched the surface of the true volume of S&E Applications. Figure 2-43 provides an inventory of the specific S&E Computer Applications that were identified by the organizations on the questionnaires. Figure 2-44 provides an inventory of application areas that were identified by the organizations on the questionnaires.

Figure 2-40 shows 43 areas which have computer applications associated with them, that Users work on. Figure 2-42 shows an additional 43 MACARS Specialty Areas that are supported by Computer Applications. Figures 2-43 and 2-44 show an additional 96 applications and 72 application areas that exist or will exist in the future. Figure 2-42 can be used to show that at least 914 unique applications support the MICOM Organizations in the 43 MACARS Specialty Areas (assuming that only one application exists per organization per MACARS category indicated as being supported within a given organization). The Users indicated that 1506 applications currently exist and that the number of applications will triple over the next ten years.

An analysis of the User Level data collected, showed that the Average User works on 5 applications. The minimum number worked on was 1 and the maximum number worked on was 50. If the number of S&E Users developed from the Organizational Level Questionnaires is reasonably accurate, then a simple estimate of 8110 applications can be developed from the 1622 S&E Users and the 5 application average per User. Viewing the issue from a different angle, the 600 sub-organizations, which exist across the 25 organizations interviewed, could be using over 6000 computer applications, if each sub-organization had only 10 applications. Both of these viewpoints are reasonable.

Although the data on the number of applications that exist and are planned for the future is at best, questionable; it can be argued that more than 1000 S&E Applications currently exist and the number of new applications will grow substantially, over the next ten years. The S&E Community expects to automate as much of their work as possible. The Users expect that adequate computer resources will be made available to them, when they need it. Unfortunately, a more rigorous analysis could not be performed, because of the lack of sufficient quality data.

The computers currently utilized by the S&E Community are relatively slow and fast becoming technically obsolete. Long-range computer planning must be done NOW to handle the expected growth in the End-User's Application Areas.

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
ANALYSIS OF USER-LEVEL QUESTIONNAIRE DATA
SUMMARY OF THE NUMBER OF APPLICATIONS BY ENGINEERING AREA
THAT INDIVIDUALS WORK ON, THE NUMBER OF APPLICATIONS THAT EXIST
AND EXPECT TO BE DEVELOPED OVER THE NEAR AND LONG TERM

ENGEERINGNM	WORK ON	CUR EXT	NEAR TERM	LONG TERM
AEROSPACE AND AERONAUTICAL ENGINEERING	113	502	336	526
CHEMICAL ENGINEERING	1	4	2	4
CIVIL ENGINEERING	2	0	0	0
COMPUTER SCIENCE	71	88	248	870
ELECTRICAL AND ELECTRONICS ENGINEERING	161	642	773	3010
FIRE PROTECTION ENGINEERING	1	0	0	0
HUMAN FACTORS ENGINEERING	2	1	10	20
INDUSTRIAL ENGINEERING	37	22	80	149
MATERIAL SCIENCE ENGINEERING	25	21	19	63
MECHANICAL ENGINEERING	26	26	64	140
NUCLEAR ENGINEERING	1	1	0	0
STRUCTURAL ENGINEERING	25	18	22	60
GENERAL ENGINEERING	2	9	12	13
DATABASE MANAGEMENT	0	0	1	2
UNIVERSAL TEST EQUIPMENT	1	1	0	0
OPERATIONS RESEARCH ANALYSIS-COST ANALYSIS	43	53	61	101
LASER MODELING	3	5	3	3
LASER PROPAGATION	3	5	3	3
PROJECT MANAGMENT RISK ANALYSIS	3	4	3	1
PHYSICS	6	6	1	1
ORSA SUPPORT-METROLOGY	2	0	0	0
MATH & STATISTICAL ANALYSIS	10	20	0	0
BUDGET AND ACCOUNTING	2	2	3	0
WEAPON SYSTEMS ANALYSIS	1	1	1	1
CONFIGURATION MANAGEMENT	3	3	2	4
LOGISTICS MANAGEMENT	12	12	12	18
COST ANALYSIS AND BUDGETING	8	11	0	0
ELECTRO-OPTICAL ANALYSIS	5	5	0	0
OPTICAL ENGINEERING	1	1	0	0
PUBLICATION PREPARATION	6	24	40	60
VALUE ENGINEERING	1	1	1	0
FACILITIES ENGINEERING	3	0	7	15
MANUFACTURING ENGINEERING	3	0	7	17
INDUSTRIAL AUTOMATION ENGINEERING	4	0	6	18
IMAGE PROCESSING	2	2	2	2
PROPERTY MANAGEMENT	1	1	1	1
ANALYTICAL CHEMISTRY	4	10	2	10
TECHNOLOGY DATABASE MANAGEMENT	2	1	1	1
TECHNICAL ILLUSTRATIONS	1	1	0	0
RELIABILITY AVAILABILITY MAINTAINABILITY	10	0	20	30
AUTOMATED CALIBRATION	1	1	1	1
RADAR	1	1	0	0
BUSINESS APPLICATIONS	1	1	1	1
TOTAL	610	1506	1745	5145

Figure 2-40 Number of Applications by Engineering Area

MICOM SCIENTFIC AND ENGINEERING COMPUTER REQUIREMENTS ANALYSIS
ANALYSIS OF USER-LEVEL QUESTIONNAIRE DATA
SUMMARY OF THE NUMBER OF APPLICATIONS THAT INDIVIDUALS WORK ON, THE NUMBER OF APPLICATIONS THAT EXIST AND EXPECT TO BE DEVELOPED OVER THE NEAR AND LONG TERM
BY ENGINEERING AREA ACROSS FUNCTIONAL AREA

ENGEERINGNM	HEADORGCD AMCPM WORK ON	CUR RENT	NEAR TERM	LONG TERM	AMSMI WORK ON	CUR RENT	NEAR TERM	LONG TERM	AMXTH WORK ON	CUR RENT	NEAR TERM	LONG TERM
AEROSPACE AND AERONAUTICAL ENGINEERING	9	11	2	2	104	491	334	524	.	.	.	.
CHEMICAL ENGINEERING	.	.	.	.	1	4	2	4	.	.	.	.
CIVIL ENGINEERING	.	.	.	.	2	0	0	0	.	.	.	.
COMPUTER SCIENCE	4	3	1	1	67	85	247	869	.	.	.	.
ELECTRICAL AND ELECTRONICS ENGINEERING	6	5	2	2	155	637	771	3008	.	.	.	.
FIRE PROTECTION ENGINEERING	.	.	.	.	1	0	0	0	.	.	.	.
HUMAN FACTORS ENGINEERING	2	1	0	0	0	0	10	20	.	.	.	.
INDUSTRIAL ENGINEERING	3	3	1	1	34	19	79	148	.	.	.	.
MATERIAL SCIENCE ENGINEERING	1	0	0	0	24	21	19	63	.	.	.	.
MECHANICAL ENGINEERING	2	1	0	0	24	25	64	140	.	.	.	.
NUCLEAR ENGINEERING	.	.	.	.	1	1	0	0	.	.	.	.
STRUCTURAL ENGINEERING	1	0	0	0	24	18	22	60	.	.	.	.
GENERAL ENGINEERING	1	7	9	10	1	2	3	3	.	.	.	.
DATABASE MANAGEMENT	0	0	1	2	.	.	.	.	.	.	.	.
UNIVERSAL TEST EQUIPMENT	.	.	.	.	1	1	0	0	.	.	.	.
OPERATIONS RESEARCH ANALYSIS-COST ANALY	2	2	0	0	41	51	61	101	.	.	.	.
LASER MODELING	.	.	.	.	3	5	3	3	.	.	.	.
LASER PROPAGATION	.	.	.	.	3	5	3	3	.	.	.	.
PROJECT MANAGMENT RISK ANALYSIS	.	.	.	.	3	4	3	1	.	.	.	.
PHYSICS	.	.	.	.	6	6	1	1	.	.	.	.
ORSA SUPPORT-METROLOGY	.	.	.	.	2	0	0	0	.	.	.	.
MATH & STATISTICAL ANALYSIS	.	.	.	.	10	20	0	0	.	.	.	.
BUDGET AND ACCOUNTING	.	.	.	.	2	2	3	0	.	.	.	.
WEAPON SYSTEMS ANALYSIS	.	.	.	.	1	1	1	1	.	.	.	.
CONFIGURATION MANAGEMENT	1	1	0	0	2	2	2	4	.	.	.	.
LOGISTICS MANAGEMENT	.	.	.	.	12	12	12	18	.	.	.	.
COST ANALYSIS AND BUDGETING	8	11	0	0	.	.	.	.	.	.	.	.
ELECTRO-OPTICAL ANALYSIS	.	.	.	.	5	5	0	0	.	.	.	.
OPTICAL ENGINEERING	.	.	.	.	1	1	0	0	.	.	.	.
PUBLICATION PREPARATION	.	.	.	.	6	24	40	60	.	.	.	.
VALUE ENGINEERING	.	.	.	.	1	1	1	0	.	.	.	.
FACILITIES ENGINEERING	.	.	.	.	3	0	7	15	.	.	.	.
MANUFACTURING ENGINEERING	.	.	.	.	3	0	7	17	.	.	.	.
INDUSTRIAL AUTOMATION ENGINEERING	.	.	.	.	4	0	6	18	.	.	.	.
IMAGE PROCESSING	.	.	.	.	2	2	2	2	.	.	.	.
PROPERTY MANAGEMENT	.	.	.	.	1	1	1	1	.	.	.	.
ANALYTICAL CHEMISTRY	.	.	.	.	4	10	2	10	.	.	.	.
TECHNOLOGY DATABASE MANAGEMENT	.	.	.	.	2	1	1	1	.	.	.	.
TECHNICAL ILLUSTRATIONS	.	.	.	.	1	1	0	0	.	.	.	.
RELIABILITY AVAILABILITY MAINTAINABILIT	.	.	.	.	10	0	20	30	.	.	.	.
AUTOMATED CALIBRATION	.	.	.	.	.	.	.	.	1	1	1	1
RADAR	.	.	.	.	1	1	0	0	.	.	.	.
BUSINESS APPLICATIONS	1	1	1	1	.	.	.	.	.	.	.	.
TOTAL	41	46	17	19	568	1459	1727	5125	1	1	1	1

Figure 2-41 Applications by Engineering Area by Functional Area

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
ESTIMATED NUMBER OF APPLICATIONS BY MACARS AREAS

AREANAME	HEADCD 1	2	3	4	6	7	9	10	13	14	17	18	19	20	21	22	23	24	25	TOTA
AUTOMATIC TEST EQUIPMENT	.	2	20	.	.	.	.	.	2	5	.	.	.	.	.	4	2	.	.	3
BUDGET & ACCOUNTING	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CHEMISTRY	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
COMMAND AND CONTROL COMMUNICATIONS	.	3	13	.	.	.	.	.	1	7	.	1	.	.	.	.	2	.	.	27
COMPUTERS	.	2	26	1	1	.	.	.	6	4	1	2	1	.	1	3	3	.	.	51
CONFIGURATION MANAGEMENT	.	2	2	1	.	1	.	.	.	4	2	2	.	1	1	2	1	4	1	24
COST AND SCHEDULE ANALYSIS	2	4	9	1	1	.	1	.	2	.	4	2	.	1	3	4	1	1	1	37
ELECTRO-MAGNETIC RADIATION	.	1	13	.	.	.	.	.	.	2	.	1	.	.	.	.	1	.	.	18
ELECTRONIC COMPONENTS	.	2	15	.	.	1	.	.	.	8	.	2	.	.	.	1	1	.	.	30
FACILITIES MANAGEMENT	.	1	.	1	.	1	.	.	.	1	.	.	.	.	.	3	.	.	.	7
FIRE CONTROL	.	.	10	.	.	1	.	.	1	4	.	2	.	.	.	1	.	.	.	19
GENERAL ENGINEERING	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
GROUND SUPPORT EQUIPMENT	.	1	8	1	.	1	.	.	1	9	1	2	.	.	.	2	.	.	1	27
GUIDANCE AND CONTROL	.	.	18	1	.	.	.	.	1	8	.	2	.	.	.	1	.	.	.	31
HUMAN FACTOR ENGINEERING	.	2	1	.	.	1	.	.	.	.	.	1	.	.	.	2	.	.	.	7
INDUSTRIAL/MANAGEMENT ENGINEERING	.	2	2	.	.	1	.	.	.	5	3	2	2	.	1	7	.	1	.	26
INFARED AND ELECTRO-OPTICAL SENSOR	.	2	15	.	.	.	.	.	1	3	.	.	.	.	.	.	.	.	.	21
INSTRUMENTATION	.	2	19	.	.	.	.	.	.	6	.	2	.	.	.	.	.	.	.	29
LASERS	.	.	11	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	13
MATERIALS	.	2	14	.	.	.	.	.	.	5	.	2	.	.	.	2	.	.	.	25
MATHEMATICS	.	1	25	1	1	.	.	.	9	1	1	2	1	.	2	4	1	.	.	49
METROLOGY	.	.	1	.	.	.	.	.	2	2	.	1	.	.	.	.	2	.	.	8
MISSILE DYNAMICS	1	1	20	1	.	1	.	.	5	6	1	2	.	.	.	2	.	.	.	40
NUCLEAR EFFECTS	.	2	3	.	.	.	.	.	.	1	.	1	.	.	.	1	.	.	.	8
OPERATIONS RESEARCH	.	4	6	.	2	.	.	1	4	3	4	1	1	.	2	3	2	1	1	35
OPTICS	.	1	14	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	18
PARTICAL BEAM	.	.	2	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	5
PRODUCT ASSURANCE	.	1	3	1	.	1	.	.	5	1	.	1	2	1	.	2	.	1	1	20
PROPULSION	1	.	11	.	.	.	.	.	.	3	.	1	.	.	.	1	.	.	.	17
RADAR	.	2	11	.	.	1	.	.	2	5	.	.	.	.	.	.	.	.	.	21
RISK ANALYSIS	1	2	4	1	.	1	.	.	1	1	4	2	.	.	5	.	1	1	1	25
SAFETY ENGINEERING AND MANAGEMENT	.	2	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	4
SEEKERS	.	.	19	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	.	23
STRUCTURES	.	.	8	.	.	1	.	.	1	6	.	1	.	.	.	1	.	.	.	18
SYSTEMS	.	2	15	.	.	.	.	.	1	4	.	2	.	.	.	2	.	.	.	26
SYSTEMS DESIGN AND DEVELOPEMENT	1	2	23	.	.	.	.	.	4	7	.	2	.	.	.	3	1	.	.	43
SYSTEMS SIMULATION	1	2	24	.	.	1	.	.	6	2	.	2	.	.	1	3	.	.	.	42
TARGETS	.	.	16	.	.	1	.	.	2	2	.	1	.	.	.	.	.	.	.	22
TECHNICAL ILLUSTRATIONS	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
TECHNICAL PUBLICATIONS	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
TELEMETRY	.	1	6	.	.	1	.	.	1	.	.	1	.	.	.	.	.	.	.	10
TEST AND EVALUATION	1	2	28	.	.	1	.	.	2	.	.	1	.	1	.	3	2	1	1	43
WARHEAD ENGINEERING	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
TOTAL	8	53	441	10	6	17	1	1	62	127	22	45	7	4	16	57	20	10	7	914

LEGEND FOR HEADCD

1.ADV MP WPN SYS PROJ OFC	2.AIR DEF COM/CON PROJ OFC	3.ARMY MISS LAB	4.CHAP/FARR PROJ OFC
5.CIV OFC TNG MGT DIV	6.CHPT	7.HAWK PROJ OFC	8.HELLFIRE/GLD PROJ OFC
9.INT LOG SUPP OFC	10.INTNAT LOG DIR	11.JNT ATAC MISS PROJ OFC	12.JTACMS PROJ OFC
13.MGT INFO SYST DIR	14.MISS LOG CNTR	15.MISS SYS READ DIR	16.MLRS PROJ OFC
17.PATRIOT PROJ OFC	18.PERSHING PROJ OFC	19.PROD ASSUR DIR	20.STINGER PROJ OFC
21.SYST ANAL EVAL OFC	22.SYS-ENG PROD DIR	23.TMDE SUPP GR	24.TOW PROJ OFC
25.US ROLAND PROJ OFC			

Figure 2-42 MACARS Areas Supported by Computer Applications

SPECIFIC APPLICATIONS IDENTIFIED BY ORGANIZATIONS

ANSYS
ASAL
Analysis and Design of Autopilots
Atmospheric Effects on Sensors
Battlefield Environment Future Weapons Systems
Boeing Grain Evaluation
Budgeting
COMO - A Framework for Creation of Computer Models
COMPOS - Composite Material Analysis of Structures
COSMOS - Static, Dynamic and Heat Transfer Analysis of Structures
Chaff, Rain, Ground Clutter Effects
Chaparral Data Collection
Chemical Equilibrium Calculations
Closed-loop Hardware Real-Time Guidance Simulation
Contractor Support Requirements Analysis
Contracts and Budget Data Base Program
Cost Operational Effectiveness Analysis
Cost Performance Analysis
DED-AMLNET + ARPANET Interface (Directed Energy Directorate)
DIACS
Data Acquisition
Database on Failures of Missile Systems
Deployment
Direct Projection from a Computer (Home video type projection)
Discrete Reliability Model
ECM (Electronic Counter Measure)
EMR TELEVENT Telemetry Data Processing
FOG-M
Fin Code
Finite Element Analysis - Pre and Post Processing
Fluid Analysis
Foreign Military Sales
Fuze Performance Simulation
Graphover
Ground Target Selector Simulation Program
Hand Receipt Inventory Data Base
Hercules Grain Evaluation
IGHTS (Ideal Gas Heat Transfer to Structures)
Intercept Contours
KTEXT
LCSS (Land Combat Support Systems)
LOGAM
Lab Automation
Laser Propagation Models
Laser System Modeling
Life Cycle Cost Model
Low Cost Data Monitoring System
MADS - Air Defense Model
"Management" Work Stations

Figure 2-43 S&E Applications Identified

SPECIFIC APPLICATIONS IDENTIFIED BY ORGANIZATIONS

Micro-Chip Library
Missile System Effectiveness Analysis
NASA Lewis LAPP Code
NASTRAN
NVL Static Performance Model for Thermal Viewing Systems
Natural Frequency and Vibration Mode Studies
Nozzle Code
OBCE (Operational Base Line Cost Estimation)
Oracle (DBMS Application)
Parametric Analysis of SAM Systems
Parametric Motor Design
Pershing II Prop Studies
Pert Charting
Point Mass Trajectory
Procurement Document Network (AMLNET)
Production and Delivery Schedules
Program to Simulate Suitable Target Selector
Propulsion Data Acquisition
RAM Analysis (Reliability, Availability, Maintainability)
RGRETS (Real Gas Recovery to Structures)
Radar Analysis Package
Radar Simulation
Ramjet
SAPVIL
SPAR
Scarfed Nozzle
Scatter - Grain Distributions
Seeker Lock-On Devices
Seekers
Service Life Prediction Code
SESAME
Static and Dynamic Analysis of Structural Systems
Stinger Simulation
Storage, Retrieval and Analysis of Sample Data for Missile Systems
System Simulation
TEXGAP-2D
TEXGAP-3D
TEXLESP
TOW-2 Simulation
Tactical Studies
Technology Database
Time Series Analysis
Trackers
Warheads
1498's Database
6 Degree of Freedom Battlefield Scenarios
6 Degree of Freedom Trajectory Analysis

Figure 2-43 S&E Applications Identified (cont'd)

APPLICATION AREAS IDENTIFIED BY ORGANIZATIONS

Aerodynamic Heating
Army Air Defense Missile Systems
Business Management
Character Recognition for Document Encoding
Communications
Computer Aided Design and Engineering (CAD,CAE)
Computer Aided Manufacturing (CAM, CNC)
Configuration Design
Contract Performance Analysis
Data Acquisition System
Database Management
Deflection Studies
Detection, Acquisition (lock on) and Tracking
Developmental Programming Languages
Drafting/Design
Dynamics
Electro-Optics
Electrical Engineering
Electronic Mail
Engineering Analysis
Engineering CAD Work Station
Engineering Drawing Preparation
Financial Management
Fuze Performance Simulation
Graphics
Heat Transfer
HP 3000 Image DBMS
HP 3000 IBM RJE Software
HP 125 Condor DBMS, VISICALC, DBASE II
Instrumentation System Controller
Inventory Management
Laboratory Data Analysis of Samples
Large-Scale Simulation
Load Analysis
Logistics
Long Range Manpower Planning for Civil Servants
Means and Variances
Millimeter Wave Studies
Missile Ballistics
Missile Systems Evaluation
Office Automation
Operations Research
Optical Guidance Systems
PERT Charts
Project Management
Propellant Stress Analysis
Propulsion Studies
Quality Control
Real-Time Test and Evaluation of G&C for Missile Systems

Figure 2-44 Application Areas Identified

APPLICATION AREAS IDENTIFIED BY ORGANIZATIONS

Regression Analysis
Reliability, Availability and Maintainability Database on Missile Systems
Report Production
Rocket Nozzle Studies
Sensors
Signatures
Simulation
Spreadsheet
Structural Analysis
Structural Analysis Composite
Survivability Assessment
Technical Report Generation
Telemetry
Trajectory Analysis
Travel Management
Various Graphware Graphics Software
Vibrations
War Games Scenarios
Warhead Studies
Weapons Aging
Weapons Battlefield Use Simulation
Weapon System Management Information
Word Processing

Figure 2-44 Application Areas Identified (cont'd)

2.3.2 Growth of the User Community

A tremendous growth in the number of Computer Users is expected at MICOM over the next ten years. A substantial growth is expected in the number of S&E Users; and, a tremendous growth is expected in the number of Supercomputer Users. Most of this growth can be attributed to the microcomputer revolution, that now provides advanced computer capabilities to non-programmers. People at MICOM, throughout the S&E Community, are now beginning to "play" with computers; and, are developing quite an interest as to what computers can do for them. They are discovering that they can make the computer do things for them, that they thought could only be done by accomplished programmers. Modern software packages make this transition possible. Many members of the S&E Community, who are not currently using computers, are very interested in developing some basic skills, which would enable them to effectively use the computer for some of their work. These people just need a little bit of training, some guidance in the selection of the proper software packages, and some ad hoc support, in order for them to develop into functioning members of the S&E Computing User Community. The growing number of Microcomputer and Minicomputer Users over the near-term, will become the Mainframe and Supercomputer Users over the long-term. IMD must anticipate and plan for the growth in the size of the User Community in its long-term strategic plans for meeting the growing needs of the S&E User Community.

The data presented in Figure 2-21 shows that the Project Management Offices, over the long-term are expecting a 231% growth (659/285) in the number of Computer Users and a 226% growth (208/92) in the number of S&E Computing Users. The Functional Directorates are expecting a 64% (1719/1045) growth in the number of Computer Users and a 34% growth (990/741) in the

number of S&E Users. The expected growth in TMDE is small, due to the large number of Computer Users that already exist.

Figure 2-45 shows the growth in the User Community indicated by each of the 25 Organizations included in the study. An analysis of this data shows that some organizations are more automated than others; and, that some organizations are more involved in S&E work than others. Higher relative percentages of growth in the number of Users are expected in the smaller PMOs like AMWS and ATM. The larger PMOs will experience substantial growth in the S&E Applications Areas, because more of their personnel are already using computers to perform some of their work. Substantial growth is also expected in the Functional Directorates. The number of Computer Users will more than double in Product Assurance and in Systems Engineering and Production. The number of S&E Users will more than triple in Product Assurance, and, increase by 60% in Systems Engineering and Production. It is also probable that a large number of S&E Users did not surface in the data collected. The data collected represented only 56% (5061/9000) of the total MICOM Community; thus, the actual numbers of Computer Users and S&E Users are expected to be greater than the sampled data demonstrates. Also, the perceptions of S&E vs Business Applications could substantially change (increase) the numbers of S&E Users.

The conclusion that the number of Computer Users will grow substantially over the next ten years is also supported by the anticipated growth in the number of minicomputers, microcomputers, word processing systems and terminals that various organizations indicated they would be acquiring in the future. After analyzing the data carefully, we estimate that the actual number of S&E Users has the potential to approach 4,000 over the next ten years, when contractors who do S&E work on the Arsenal are included in the estimate.

Another type of growth in the User Community, that must be recognized and planned for, is the growth in the sophistication level of the Users and the complexity of the work that they are performing. As the S&E Community becomes more dependent upon analytical techniques that address analysis of the problem from a total system approach, the algorithms become more complex and need to be created by more complex individual Users. And, more complex individuals create more demands for raw computing power to be made readily available to them. Thus, the new computing power that the MICOM S&E Community needs now, at the Central Computing Facility, is on the order of magnitude of ten to twenty times the current capabilities. In the long-term, it is conceivable that the expected number of 175 Supercomputer Users at MICOM would need a processor that is one hundred times faster than the existing mainframes. A 300 - 600 MIP Supercomputer will be required within the next decade, to support the growth in the S&E User Community.

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
ANALYSIS OF THE SIZE OF THE USER COMMUNITY BY ORGANIZATION
ORGANIZATIONAL QUESTIONNAIRE 4-1 4-2 4-3 4-7

HEADORGCD		LNAME					
AMCPM-ADCC		AIR DEFENSE COMMAND AND CONTROL SYSTEMS PROJECT OFFICE					
1A41	77	1A42	9	1A43	3	1A47	0
1B41	3	1B42	2	1B43	0	1B47	0
1C41	13	1C42	8	1C43	6	1C47	0
1T41	93	1T42	19	1T43	9	1T47	0
2A41	92	2A42	41	2A43	19	2A47	0
2B41	3	2B42	3	2B43	1	2B47	0
2C41	13	2C42	8	2C43	6	2C47	0
2T41	108	2T42	52	2T43	26	2T47	0
3A41	100	3A42	55	3A43	26	3A47	0
3B41	5	3B42	4	3B43	1	3B47	0
3C41	10	3C42	4	3C43	1	3C47	0
3T41	115	3T42	63	3T43	28	3T47	0
AMCPM-AMWS		ADVANCED MANPORTABLE WEAPON SYSTEMS PROJECT OFFICE					
1A41	35	1A42	3	1A43	1	1A47	0
1B41	5	1B42	0	1B43	0	1B47	0
1C41	1	1C42	1	1C43	0	1C47	0
1T41	41	1T42	4	1T43	1	1T47	0
2A41	35	2A42	11	2A43	16	2A47	0
2B41	5	2B42	2	2B43	1	2B47	0
2C41	1	2C42	1	2C43	0	2C47	0
2T41	41	2T42	14	2T43	17	2T47	0
3A41	50	3A42	25	3A43	16	3A47	0
3B41	10	3B42	10	3B43	2	3B47	0
3C41	1	3C42	1	3C43	0	3C47	0
3T41	61	3T42	36	3T43	18	3T47	0
AMCPM-ATM		JOINT ANTITACTICAL MISSILE SYSTEM PROJECT OFFICE					
1A41	20	1A42	8	1A43	1	1A47	0
1B41	1	1B42	0	1B43	0	1B47	0
1C41	0	1C42	0	1C43	0	1C47	0
1T41	21	1T42	8	1T43	1	1T47	0
2A41	20	2A42	4	2A43	3	2A47	0
2B41	0	2B42	0	2B43	0	2B47	0
2C41	0	2C42	0	2C43	0	2C47	0
2T41	20	2T42	4	2T43	3	2T47	0
3A41	50	3A42	30	3A43	10	3A47	3
3B41	5	3B42	5	3B43	1	3B47	1
3C41	0	3C42	0	3C43	0	3C47	0
3T41	55	3T42	35	3T43	11	3T47	4
AMCPM-CF		CHAPARRAL/FAAR PROJECT OFFICE					
1A41	119	1A42	25	1A43	2	1A47	0
1B41	6	1B42	2	1B43	1	1B47	0
1C41	4	1C42	3	1C43	0	1C47	0
1T41	129	1T42	30	1T43	3	1T47	0
2A41	125	2A42	69	2A43	7	2A47	5
2B41	6	2B42	5	2B43	1	2B47	1
2C41	4	2C42	4	2C43	0	2C47	0
2T41	135	2T42	78	2T43	8	2T47	6
3A41	129	3A42	105	3A43	12	3A47	10
3B41	7	3B42	5	3B43	1	3B47	1
3C41	4	3C42	4	3C43	0	3C47	0
3T41	140	3T42	114	3T43	13	3T47	11

LEGEND: XY41=# OF PEOPLE
XY42=# OF COMPUTER USERS
XY43=# OF S AND E USERS
XY47=# SUPERCOMPUTER USERS

Y=A-CIVILIAN
B-MILITARY
C-CONTRACTOR

X=1-CURRENT
2-NEAR TERM
3-LONG TERM

Figure 2-45 Size of User Community by Major MICOM Organization

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
ANALYSIS OF THE SIZE OF THE USER COMMUNITY BY ORGANIZATION
ORGANIZATIONAL QUESTIONNAIRE 4-1 4-2 4-3 4-7

HEADORGCD		LNAME					
AMCPM-HA		HAWK PROJECT OFFICE					
1A41	68	1A42	10	1A43	4	1A47	0
1B41	1	1B42	0	1B43	0	1B47	0
1C41	0	1C42	0	1C43	0	1C47	0
1T41	69	1T42	10	1T43	4	1T47	0
2A41	69	2A42	17	2A43	6	2A47	0
2B41	1	2B42	0	2B43	0	2B47	0
2C41	0	2C42	0	2C43	0	2C47	0
2T41	70	2T42	17	2T43	6	2T47	0
3A41	70	3A42	30	3A43	6	3A47	0
3B41	1	3B42	0	3B43	0	3B47	0
3C41	0	3C42	0	3C43	0	3C47	0
3T41	71	3T42	30	3T43	6	3T47	0
AMCPM-HD		HELLFIRE/GROUND LASER DESIGNATOR PROJECT OFFICE					
1A41	95	1A42	48	1A43	20	1A47	0
1B41	16	1B42	5	1B43	0	1B47	0
1C41	11	1C42	11	1C43	0	1C47	0
1T41	122	1T42	64	1T43	20	1T47	0
2A41	103	2A42	71	2A43	26	2A47	0
2B41	17	2B42	10	2B43	0	2B47	0
2C41	8	2C42	8	2C43	0	2C47	0
2T41	128	2T42	89	2T43	26	2T47	0
3A41	105	3A42	73	3A43	31	3A47	0
3B41	17	3B42	10	3B43	0	3B47	0
3C41	7	3C42	7	3C43	0	3C47	0
3T41	129	3T42	90	3T43	31	3T47	0
AMCPM-JM		JOINT TACTICAL MISSILE SYSTEMS PROJECT OFFICE					
1A41	52	1A42	6	1A43	0	1A47	0
1B41	3	1B42	0	1B43	0	1B47	0
1C41	1	1C42	1	1C43	0	1C47	0
1T41	56	1T42	7	1T43	0	1T47	0
2A41	100	2A42	12	2A43	6	2A47	0
2B41	15	2B42	0	2B43	0	2B47	0
2C41	1	2C42	1	2C43	0	2C47	0
2T41	116	2T42	13	2T43	6	2T47	0
3A41	100	3A42	18	3A43	6	3A47	0
3B41	15	3B42	0	3B43	0	3B47	0
3C41	1	3C42	1	3C43	0	3C47	0
3T41	116	3T42	19	3T43	6	3T47	0
AMCPM-MD		PATRIOT PROJECT OFFICE					
1A41	98	1A42	36	1A43	9	1A47	0
1B41	16	1B42	3	1B43	1	1B47	0
1C41	14	1C42	12	1C43	2	1C47	0
1T41	128	1T42	51	1T43	12	1T47	0
2A41	91	2A42	49	2A43	12	2A47	0
2B41	11	2B42	7	2B43	2	2B47	0
2C41	14	2C42	12	2C43	2	2C47	0
2T41	116	2T42	68	2T43	16	2T47	0
3A41	92	3A42	56	3A43	15	3A47	0
3B41	12	3B42	7	3B43	2	3B47	0
3C41	12	3C42	12	3C43	2	3C47	0
3T41	116	3T42	75	3T43	19	3T47	0

LEGEND: XY41=# OF PEOPLE
XY42=# OF COMPUTER USERS
XY43=# OF S AND E USERS
XY47=# SUPERCOMPUTER USERS

Y=A-CIVILIAN
B-MILITARY
C-CONTRACTOR

X=1-CURRENT
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3-LONG TERM

Figure 2-45 Size of User Community by Major MICOM Organization (cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
ANALYSIS OF THE SIZE OF THE USER COMMUNITY BY ORGANIZATION
ORGANIZATIONAL QUESTIONNAIRE 4-1 4-2 4-5 4-7

HEADORGCD		LNAME					
AMCPM-MP		STINGER PROJECT OFFICE					
1A41	65	1A42	16	1A43	2	1A47	0
1B41	3	1B42	0	1B43	0	1B47	0
1C41	2	1C42	2	1C43	1	1C47	0
1T41	70	1T42	18	1T43	3	1T47	0
2A41	70	2A42	27	2A43	4	2A47	0
2B41	2	2B42	0	2B43	0	2B47	0
2C41	2	2C42	2	2C43	1	2C47	0
2T41	74	2T42	29	2T43	5	2T47	0
3A41	74	3A42	38	3A43	0	3A47	0
3B41	2	3B42	0	3B43	0	3B47	0
3C41	2	3C42	2	3C43	2	3C47	0
3T41	78	3T42	40	3T43	2	3T47	0
AMCPM-PE		PERSHING PROJECT OFFICE					
1A41	149	1A42	33	1A43	21	1A47	0
1B41	22	1B42	18	1B43	14	1B47	0
1C41	0	1C42	0	1C43	0	1C47	0
1T41	171	1T42	51	1T43	35	1T47	0
2A41	171	2A42	55	2A43	31	2A47	20
2B41	24	2B42	19	2B43	14	2B47	14
2C41	0	2C42	0	2C43	0	2C47	0
2T41	195	2T42	74	2T43	45	2T47	34
3A41	171	3A42	70	3A43	36	3A47	20
3B41	24	3B42	19	3B43	14	3B47	14
3C41	0	3C42	0	3C43	0	3C47	0
3T41	195	3T42	89	3T43	50	3T47	34
AMCPM-ROL		UNITED STATES ROLAND PROJECT OFFICE					
1A41	60	1A42	6	1A43	1	1A47	0
1B41	4	1B42	0	1B43	0	1B47	0
1C41	16	1C42	8	1C43	1	1C47	0
1T41	80	1T42	14	1T43	2	1T47	0
2A41	35	2A42	18	2A43	2	2A47	0
2B41	2	2B42	0	2B43	0	2B47	0
2C41	10	2C42	5	2C43	1	2C47	0
2T41	47	2T42	23	2T43	3	2T47	0
3A41	0	3A42	0	3A43	0	3A47	0
3B41	0	3B42	0	3B43	0	3B47	0
3C41	0	3C42	0	3C43	0	3C47	0
3T41	0	3T42	0	3T43	0	3T47	0
AMCPM-RS		MULTIPLE LAUNCH ROCKET SYSTEM PROJECT OFFICE					
1A41	31	1A42	5	1A43	1	1A47	0
1B41	1	1B42	1	1B43	1	1B47	0
1C41	10	1C42	3	1C43	0	1C47	0
1T41	42	1T42	9	1T43	2	1T47	0
2A41	35	2A42	17	2A43	3	2A47	0
2B41	1	2B42	1	2B43	1	2B47	0
2C41	10	2C42	3	2C43	0	2C47	0
2T41	46	2T42	21	2T43	4	2T47	0
3A41	23	3A42	23	3A43	1	3A47	0
3B41	1	3B42	1	3B43	0	3B47	0
3C41	3	3C42	3	3C43	0	3C47	0
3T41	27	3T42	27	3T43	1	3T47	0

LEGEND: XY41=# OF PEOPLE
XY42=# OF COMPUTER USERS
XY43=# OF S AND E USERS
XY47=# SUPERCOMPUTER USERS

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X=1-CURRENT
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Figure 2-45 Size of User Community by Major MICOM Organization (cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
ANALYSIS OF THE SIZE OF THE USER COMMUNITY BY ORGANIZATION
ORGANIZATIONAL QUESTIONNAIRE 4-1 4-2 4-3 4-7

HEADORGCD		LNAME					
AMCPM-TO		TOW PROJECT OFFICE					
1A41	37	1A42	0	1A43	0	1A47	0
1B41	0	1B42	0	1B43	0	1B47	0
1C41	0	1C42	0	1C43	0	1C47	0
1T41	37	1T42	0	1T43	0	1T47	0
2A41	44	2A42	26	2A43	6	2A47	1
2B41	0	2B42	0	2B43	0	2B47	0
2C41	0	2C42	0	2C43	0	2C47	0
2T41	44	2T42	26	2T43	6	2T47	1
3A41	47	3A42	41	3A43	23	3A47	4
3B41	0	3B42	0	3B43	0	3B47	0
3C41	0	3C42	0	3C43	0	3C47	0
3T41	47	3T42	41	3T43	23	3T47	4
AMSMI-D		SYSTEMS ANALYSIS AND EVALUATION OFFICE					
1A41	28	1A42	28	1A43	14	1A47	0
1B41	0	1B42	0	1B43	0	1B47	0
1C41	2	1C42	2	1C43	0	1C47	0
1T41	30	1T42	30	1T43	14	1T47	0
2A41	28	2A42	28	2A43	14	2A47	13
2B41	0	2B42	0	2B43	0	2B47	0
2C41	2	2C42	2	2C43	0	2C47	2
2T41	30	2T42	30	2T43	14	2T47	15
3A41	28	3A42	28	3A43	14	3A47	13
3B41	0	3B42	0	3B43	0	3B47	0
3C41	2	3C42	2	3C43	0	3C47	2
3T41	30	3T42	30	3T43	14	3T47	15
AMSMI-E		SYSTEMS-ENGINEERING AND PRODUCTION DIRECTORATE					
1A41	215	1A42	120	1A43	106	1A47	0
1B41	0	1B42	0	1B43	0	1B47	0
1C41	5	1C42	5	1C43	5	1C47	0
1T41	220	1T42	125	1T43	111	1T47	0
2A41	256	2A42	196	2A43	138	2A47	6
2B41	0	2B42	0	2B43	0	2B47	0
2C41	3	2C42	3	2C43	1	2C47	0
2T41	259	2T42	199	2T43	139	2T47	6
3A41	289	3A42	252	3A43	176	3A47	17
3B41	0	3B42	0	3B43	0	3B47	0
3C41	5	3C42	5	3C43	2	3C47	0
3T41	294	3T42	257	3T43	178	3T47	17
AMSMI-F		COMPTROLLER					
1A41	95	1A42	70	1A43	2	1A47	0
1B41	1	1B42	1	1B43	1	1B47	0
1C41	0	1C42	0	1C43	0	1C47	0
1T41	96	1T42	71	1T43	3	1T47	0
2A41	92	2A42	84	2A43	5	2A47	0
2B41	1	2B42	1	2B43	1	2B47	0
2C41	0	2C42	0	2C43	0	2C47	0
2T41	93	2T42	85	2T43	6	2T47	0
3A41	95	3A42	93	3A43	6	3A47	0
3B41	1	3B42	1	3B43	1	3B47	0
3C41	0	3C42	0	3C43	0	3C47	0
3T41	96	3T42	94	3T43	7	3T47	0

LEGEND: XY41=# OF PEOPLE
XY42=# OF COMPUTER USERS
XY43=# OF S AND E USERS
XY47=# SUPERCOMPUTER USERS

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Figure 2-45 Size of User Community by Major MICOM Organization (cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
ANALYSIS OF THE SIZE OF THE USER COMMUNITY BY ORGANIZATION
ORGANIZATIONAL QUESTIONNAIRE 4-1 4-2 4-3 4-7

HEADORGCD	LNAME						
AMSMI-H	INTEGRATED LOGISTICS SUPPORT OFFICE						
1A41	33	1A42	4	1A43	0	1A47	0
1B41	2	1B42	0	1B43	0	1B47	0
1C41	1	1C42	1	1C43	0	1C47	0
1T41	36	1T42	5	1T43	0	1T47	0
2A41	35	2A42	8	2A43	0	2A47	0
2B41	2	2B42	2	2B43	0	2B47	0
2C41	1	2C42	1	2C43	0	2C47	0
2T41	38	2T42	11	2T43	0	2T47	0
3A41	40	3A42	10	3A43	0	3A47	0
3B41	2	3B42	2	3B43	0	3B47	0
3C41	1	3C42	1	3C43	0	3C47	0
3T41	43	3T42	13	3T43	0	3T47	0
AMSMI-JT	CIVILIAN PERSONNEL OFFICE TRAINING AND CAREER MGT DIVISION						
1A41	28	1A42	2	1A43	0	1A47	0
1B41	0	1B42	0	1B43	0	1B47	0
1C41	7	1C42	7	1C43	0	1C47	0
1T41	35	1T42	9	1T43	0	1T47	0
2A41	30	2A42	3	2A43	0	2A47	0
2B41	0	2B42	0	2B43	0	2B47	0
2C41	13	2C42	13	2C43	0	2C47	0
2T41	43	2T42	16	2T43	0	2T47	0
3A41	30	3A42	3	3A43	0	3A47	0
3B41	13	3B42	10	3B43	0	3B47	0
3C41	0	3C42	13	3C43	0	3C47	0
3T41	43	3T42	26	3T43	0	3T47	0
AMSMI-Q	PRODUCT ASSURANCE DIRECTORATE						
1A41	158	1A42	63	1A43	28	1A47	0
1B41	1	1B42	1	1B43	1	1B47	0
1C41	0	1C42	0	1C43	0	1C47	0
1T41	159	1T42	64	1T43	29	1T47	0
2A41	170	2A42	170	2A43	87	2A47	0
2B41	1	2B42	1	2B43	1	2B47	0
2C41	0	2C42	0	2C43	0	2C47	0
2T41	171	2T42	171	2T43	88	2T47	0
3A41	170	3A42	170	3A43	97	3A47	0
3B41	1	3B42	1	3B43	1	3B47	0
3C41	0	3C42	0	3C43	0	3C47	0
3T41	171	3T42	171	3T43	98	3T47	0
AMSMI-R	ARMY MISSILE LABORATORY						
1A41	881	1A42	458	1A43	399	1A47	5
1B41	16	1B42	4	1B43	1	1B47	0
1C41	231	1C42	130	1C43	128	1C47	3
1T41	1128	1T42	592	1T43	528	1T47	8
2A41	902	2A42	451	2A43	360	2A47	21
2B41	15	2B42	7	2B43	2	2B47	0
2C41	236	2C42	150	2C43	145	2C47	5
2T41	1153	2T42	608	2T43	507	2T47	26
3A41	924	3A42	546	3A43	443	3A47	73
3B41	19	3B42	9	3B43	3	3B47	1
3C41	240	3C42	165	3C43	173	3C47	10
3T41	1183	3T42	720	3T43	619	3T47	84

LEGEND: XY41=# OF PEOPLE
XY42=# OF COMPUTER USERS
XY43=# OF S AND E USERS
XY47=# SUPERCOMPUTER USERS

Y=A-CIVILIAN
B-MILITARY
C-CONTRACTOR

X=1-CURRENT
2-NEAR TERM
3-LONG TERM

Figure 2-43 Size of User Community by Major MICOM Organization (cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
ANALYSIS OF THE SIZE OF THE USER COMMUNITY BY ORGANIZATION
ORGANIZATIONAL QUESTIONNAIRE 4-1 4-2 4-3 4-7

HEADORGCD		LNAME					
AMSMI-S		MISSILE LOGISTICS CENTER					
1A41	29	1A42	25	1A43	17	1A47	0
1B41	0	1B42	0	1B43	0	1B47	0
1C41	11	1C42	11	1C43	0	1C47	0
1T41	40	1T42	36	1T43	17	1T47	0
2A41	37	2A42	33	2A43	19	2A47	0
2B41	0	2B42	0	2B43	0	2B47	0
2C41	7	2C42	7	2C43	0	2C47	0
2T41	44	2T42	40	2T43	19	2T47	0
3A41	28	3A42	24	3A43	24	3A47	0
3B41	0	3B42	0	3B43	0	3B47	0
3C41	0	3C42	0	3C43	0	3C47	0
3T41	28	3T42	24	3T43	24	3T47	0
AMSMI-U		MISSILE SYSTEMS READINESS DIRECTORATE					
1A41	200	1A42	35	1A43	0	1A47	0
1B41	6	1B42	5	1B43	0	1B47	0
1C41	33	1C42	1	1C43	0	1C47	0
1T41	239	1T42	41	1T43	0	1T47	0
2A41	225	2A42	191	2A43	0	2A47	0
2B41	6	2B42	5	2B43	0	2B47	0
2C41	36	2C42	1	2C43	0	2C47	0
2T41	267	2T42	197	2T43	0	2T47	0
3A41	235	3A42	202	3A43	0	3A47	0
3B41	6	3B42	5	3B43	0	3B47	0
3C41	36	3C42	1	3C43	0	3C47	0
3T41	277	3T42	208	3T43	0	3T47	0
AMSMI-W		MANAGEMENT INFOMATION SYSTEMS DIRECTORATE					
1A41	34	1A42	34	1A43	34	1A47	1
1B41	0	1B42	0	1B43	0	1B47	0
1C41	3	1C42	3	1C43	3	1C47	0
1T41	37	1T42	37	1T43	37	1T47	1
2A41	34	2A42	34	2A43	34	2A47	3
2B41	0	2B42	0	2B43	0	2B47	0
2C41	5	2C42	5	2C43	5	2C47	1
2T41	39	2T42	39	2T43	39	2T47	4
3A41	35	3A42	35	3A43	35	3A47	5
3B41	0	3B42	0	3B43	0	3B47	0
3C41	5	3C42	5	3C43	5	3C47	1
3T41	40	3T42	40	3T43	40	3T47	6
AMSMI-Z		INTERNATIONAL LOGISTICS DIRECTORATE					
1A41	113	1A42	35	1A43	2	1A47	0
1B41	2	1B42	0	1B43	0	1B47	0
1C41	0	1C42	0	1C43	0	1C47	0
1T41	115	1T42	35	1T43	2	1T47	0
2A41	169	2A42	136	2A43	3	2A47	0
2B41	4	2B42	0	2B43	0	2B47	0
2C41	0	2C42	0	2C43	0	2C47	0
2T41	173	2T42	136	2T43	3	2T47	0
3A41	169	3A42	136	3A43	10	3A47	0
3B41	4	3B42	0	3B43	0	3B47	0
3C41	0	3C42	0	3C43	0	3C47	0
3T41	173	3T42	136	3T43	10	3T47	0

LEGEND: XY41=# OF PEOPLE
XY42=# OF COMPUTER USERS
XY43=# OF S AND E USERS
XY47=# SUPERCOMPUTER USERS

Y=A-CIVILIAN
B-MILITARY
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X=1-CURRENT
2-NEAR TERM
3-LONG TERM

Figure 2-45 Size of User Community by Major MICOM Organization (cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
ANALYSIS OF THE SIZE OF THE USER COMMUNITY BY ORGANIZATION
ORGANIZATIONAL QUESTIONNAIRE 4-1 4-2 4-3 4-7

HEADORGCD		LNAME					
AMXTM-X		TMDE SUPPORT GROUP					
1A41	1058	1A42	945	1A43	637	1A47	0
1B41	468	1B42	172	1B43	117	1B47	0
1C41	50	1C42	50	1C43	35	1C47	0
1T41	1576	1T42	1167	1T43	789	1T47	0
2A41	1064	2A42	977	2A43	641	2A47	0
2B41	408	2B42	178	2B43	117	2B47	0
2C41	50	2C42	50	2C43	35	2C47	0
2T41	1522	2T42	1205	2T43	793	2T47	0
3A41	1075	3A42	986	3A43	643	3A47	0
3B41	408	3B42	173	3B43	117	3B47	0
3C41	50	3C42	50	3C43	35	3C47	0
3T41	1533	3T42	1209	3T43	795	3T47	0
TOTAL							
1A41	3778	1A42	2024	1A43	1304	1A47	6
1B41	577	1B42	214	1B43	137	1B47	0
1C41	415	1C42	259	1C43	181	1C47	3
1T41	4770	1T42	2497	1T43	1622	1T47	9
2A41	4032	2A42	2728	2A43	1442	2A47	69
2B41	524	2B42	241	2B43	141	2B47	15
2C41	416	2C42	276	2C43	196	2C47	8
2T41	4972	2T42	3245	2T43	1779	2T47	92
3A41	4129	3A42	3049	3A43	1630	3A47	145
3B41	553	3B42	262	3B43	143	3B47	17
3C41	379	3C42	276	3C43	220	3C47	13
3T41	5061	3T42	3587	3T43	1993	3T47	175

LEGEND: XY41=# OF PEOPLE
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XY43=# OF S AND E USERS
XY47=# SUPERCOMPUTER USERS

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X=1-CURRENT
2-NEAR TERM
3-LONG TERM

Figure 2-45 Size of User Community by Major MICOM Organization (cont'd)

2.3.3 Advancement of Technology

Current technology advancements in the computer area will continue at a rapid pace, throughout the next decade. The advancements in microelectronics, microprocessor and computer memory technology, that have brought forth the personal computer, the super-minicomputer, more power mainframes, supercomputers and high-speed local area networks, will continue to deliver faster and cheaper computers and peripheral devices. According to recent technology reports, the cost of computing power will continue to decline as the processing power at all levels of computers continues to increase. The increase in processing power is expected to increase ten-fold every 10 years, at all levels of computers. Advancements in technology will produce: desktop microcomputers that have the capability of executing between 1 to 4 Million Instructions per Second (MIPS); super-minicomputers in the 4 to 100 MIPS range; mainframes in the 60 to 500 MIP range; and supercomputers that can execute in excess of 10 Billion Instructions Per Second.

Similar advancements in computer memory technology will place hundreds of megabytes of central memory in microcomputers through mainframes; and, gigabytes of memory will be available on advanced supercomputers. Disk storage technology will produce storage devices capable of handling hundreds of billions of characters of data. Optical and laser disk technology will provide gigabyte storage capabilities to all levels of computer hardware: micros through supercomputers. High-speed laser and ink-jet printers will effectively replace the impact printing techniques (daisywheel, dot matrix, hammer, etc.) that are currently in use. Ink-jet printers, which can print Scientific and Greek characters, as well as graphics, will become very suitable for S&E work.

Office Automation Technology will produce powerful multi-function workstations, which will integrate Data Processing, Word Processing and Scientific and Personal Computing Capabilities. Integrated Engineering Workstations of the future will possess, what is now considered to be, mainframe computing power. Faster terminals and color graphics devices will be developed to complement the faster computing environment.

Tremendous advancements are also expected in digitized voice, synthesized voice, voice recognition, pattern recognition, conferencing, teleconferencing, image processing, and data, voice, video and facsimile transmission. Telecommunications processing, networking and communications technologies will provide the vehicle for information exchange between computers and peripheral equipment connected to high-speed local area networks. Communications will be the single most important element of a successful Scientific and Engineering Computing Environment. Megabyte through gigabyte data links will become commonplace.

IMD must develop and maintain a sufficient level of expertise in the area of New Technology Assessment. IMD must seek out and explore new technologies and evaluate their potential usefulness to the Scientific and Engineering Community. As new technology is deemed useful, it should be introduced into the S&E Computing Environment at MICOM, for the benefit of the End-Users. IMD must also develop appropriate contractual vehicles to provide State-of-the-Art Computing Equipment to the End-Users, in more reasonable timeframes. The new computer technology will continue to be available from industry; but, the ADP Acquisition Process must be shortened considerably to industry timeframes, before the S&E Community will directly benefit from the new technology in reasonable timeframes.

2.4 A Definition of the Problem

This section provides a definition of the Scientific and Engineering Computing problem that exists at MICOM. It provides an assessment of the magnitude of the problem, the complexity of the problem and an analysis of the major components of the problem.

2.4.1 Magnitude of the Problem

The study revealed that MICOM does not have a state-of-the-art Scientific and Engineering Computing Facility. The current centralized CDC 6600 and CYBER 74 mainframes are obsolete, difficult and too costly to maintain, and do not have sufficient central memory to support larger S&E Application programs. As a result of the inadequate hardware capabilities that exist at the S&E Central Computing Facility, over 50% of the S&E Computing workload has migrated away from the Central Facility. As the workload migrated to competing computer facilities, IMD was forced to raise their rates for computer time. The increasing rates for computer time helped to accelerate the migration of workload to other alternatives. The situation is now so bad, that if the central mainframes are not replaced immediately, the S&E Computing Facility will be forced out of business in twelve to sixteen months. The Users will simply move all their computing workload to computers that satisfy their needs at a more reasonable cost. The magnitude of the problem is great and the need for top management action has become critical.

The study also revealed that the minicomputers and microcomputers that have been picking-up the S&E Computing Workload are approaching saturation points. More powerful hardware is needed to handle anticipated increases in the S&E Computing Workload. The Users are interested in obtaining more new

hardware and obtaining more memory, CPUs, disk storage and other peripheral devices to expand their remote computing capabilities.

Users from 24 major MICOM organizations have developed the attitude that they are on their own, as they seek out ways to meet their ADP needs. Many Users have given up hope that IMD will provide more adequate hardware, software and telecommunications services to meet the User's needs. IMD, in failing to provide, what is in the User's opinion, adequate hardware and software services to the User Community at a reasonable price, has developed a credibility problem with the User Community. This credibility issue can be resolved with swift and decisive top management action in developing and adopting a long-range plan towards meeting the TOTAL S&E REQUIREMENTS on a turnkey basis.

2.4.2 Complexity of the Problem

The MICOM Scientific and Engineering Community has become more dependent upon computers over the last ten years, as evidenced by the dramatic growth in the number of computers installed on the Arsenal. As the weapons systems become more complex, the complexity of the S&E Community will increase proportionately. The demands, for significantly faster computers and more increasingly complex software capabilities, will continue to grow over the next decade. The demands for more advanced telecommunications services and support services will continue to grow. The problem in meeting these increased needs for service is very complex, because the variety of services required spans: hardware, software, telecommunications, equipment availability and access, analyst support, contractor support, training, programming, consulting, End-User hand-holding, etc. The User Community is

growing rapidly and is expected to double or triple over the next decade. The S&E Community uses hardware provided by over 107 different hardware vendors. They use hundreds of software packages provided by as many software vendors. They work on thousands of S&E Applications in hundreds of different specialty areas. The variety of hardware and software used by a rather large User Community makes the services and support problem very complicated. The Users expect that IMD will provide the services required in industry timeframes; but the Users are not aware of the fact that IMD has staffing limitations and budgeting restraints, like everyone else does. The expectations of the User Community far exceed IMD's capability to satisfy all the User's wants and desires. IMD will need to decide what level of support will be directly provided in which areas; and develop alternate means of supporting the varied User's needs.

The task of adequately supporting the computing needs of the Scientific and Engineering Community is very complex, but the task can be carried out successfully and to the satisfaction of the End-Users, if the Major Organizations at MICOM learn to cooperate and work together for the good of the Command.

2.4.3 Analysis of the Components of the Problem

The Scientific and Engineering Computing Problem that exists at MICOM is not one problem, but is many problems that contribute to the overall problem of the existence of a poor Scientific and Engineering Computing Environment at MICOM. The principal components of the problem are: technical problems, organizational problems, political problems, economic problems, management problems, procurement problems, User problems, training problems and support problems.

The technical Scientific and Engineering Computing problems that exist at MICOM point to the areas of inadequate computer hardware, software and telecommunications capabilities that do not meet the growing demands of an expanding User Community. The computers, at the Central Computing Facility and throughout the remote computing centers on the Arsenal, are simply too slow to provide reasonable response times to the S&E Users. Many of the computers need substantial central memory upgrades to improve the response times provided to the End-Users. The software capabilities provided do not meet the User's demand for more "User Friendly" and "Easy to Use" software packages. And, the demands for state-of-the-art telecommunications networking service, have not been satisfied. These technical issues can be resolved, if MICOM adopts a posture to provide and maintain a superior state-of-the-art Scientific and Engineering Computing Environment, for the Users. A significant amount of valuable and very expensive Scientist and Engineer manpower time is wasted every day as people wait for the computers to execute their jobs.

The organizational level problems that exist at MICOM include: a critical shortage of properly trained personnel who can effectively deal with

state-of-the-art S&E hardware, software and telecommunications problems and issues; non-technically-oriented management; management resistance to change and the desire to remain status quo; fears that automation will cause staffing reductions; lack of equipment and lack of budget. These problems, coupled with: the observed lack of the spirit of cooperation and willingness to cooperate and communicate specific requirements to long-term strategic planning efforts; the expressed desire of many organizations wanting to do more of "their own thing"; and the lack of sufficient joint long-term strategic planning efforts; have helped to create the existing S&E Computing Problem at MICOM. These problems can be resolved, if organizations at MICOM learn to cooperate, both in discussing their problems and jointly working, on constructive solutions to their common problems and needs, with the appropriate service organizations, which have been established at MICOM for various purposes. All of the MICOM organizations need to become more dependent on each other and share their resources; and, the service organizations need to become more service-oriented in executing their appointed SERVICE MISSIONS. The organizations themselves are part of the problem, and unless they decide that they will become part of the solution to the problem, the problem will continue to exist and probably get worse.

The political aspect of the problem exists for many reasons. But, the main reason is the way the service organizations have been established at MICOM, with responsibility over certain areas, like ADP and Telecommunications; and, the associated authority or control over ADP resources, training, R&D direction, etc., that is delegated to the various service organizations that exist by organizational charter. Organizational structure, management and authority create political problems by their very existence. Political conflicts arise between the organizations, who would

rather control their own resources, than be reliant upon some other organization for certain resources, services and support. If politics is permitted to influence the technical direction that the Command takes in addressing the S&E Computing Environment Problem, then politics is part of the problem. The net result remains that the Command will continue to spend hundreds of millions of dollars on ADPE equipment that is inadequate for the needs of the S&E Users, but facilitates ease of procurement and local politics. Attempting to address the TOTAL S&E REQUIREMENTS on a turnkey basis, is the recommended course of action, but is bound to meet with political problems, over the issue of who "controls" the hardware, software and telecommunications resources. Top Command Management must pursue a cost-effective long-range technical solution to the S&E Computing problem that exists at MICOM, and make local politics a secondary issue to cost-effectiveness.

The economic problem exists in that organizations, years in advance, budget certain amounts of dollars for purchasing ADPE, and, for purchasing certain amounts of mainframe computer time and other services, from service organizations like IMD. When an organization experiences a greater demand for mainframe computer time than had been budgeted for, the organization must acquire additional funding or seek out cheaper services. In the Past, many organizations have chosen the latter alternative. This phenomenon causes an economic problem for the service organization, which must increase its rates for computer time, in order to recover the fixed operations and maintenance costs. This is a direct result of Industrial Fund Accounting practices. As an economic ripple-effect develops, the rates for service continue to escalate, as the number of buyers decreases. This continues to influence a

decrease in the number of buyers, which results in more rate increases. If permitted to continue, the ultimate consequence can be the economic demise of an organization. A potential solution to the economic problem, could be the adoption of some creative pricing strategies, that would encourage more use of the Central Computing Facilities, based upon some "fixed price" components and some "pay as you go" items.

The basic management problem, that exists at MICOM, is that Management's perception of the User's needs conflicts with the User's wants and desires. Some managers may lack current technical expertise in the areas they are responsible for managing; and, therefore, cannot appreciate the User's technical problems, wants, needs and desires. Management is responsible for the allocation of scarce economic resources; and, often, is doing the best allocation, within their budgetary constraints. Management action is often hindered by the "system". The User's do not appreciate the problems that the managers deal with, within the confines of the "system", and conclude that management is not doing anything to solve their problems. More open and more frequent communications between Management and the Users can be used to bridge the gap that exists between Management and the Users. Both groups must learn to understand each other's problems and limitations; and, learn to cooperate more in mutually solving their problems.

The basic problem with the procurement process, regarding the S&E Environment, is that it takes too long and requires too much paperwork, to replace the ADP equipment, when it is necessary. New equipment can be obsolete, before it is even delivered. So much justification is required to get the initial procurement approval, that years can pass by just in obtaining the approval to procure the necessary equipment. More years can pass by,

until the equipment is delivered. In the meantime, the entire S&E Community suffers due to lack of adequate mainframe computer hardware. The Users get tired of waiting and turn to obtaining as many minicomputers, as they possibly can, to meet their needs. The Users are happy for a while, until their new minicomputers get saturated, then it's time to buy more minicomputers. The dollars spent on computer hardware continue to increase, but sufficient computer power is still not available to the Users. The procurement process encourages the acquisition of less powerful computers, than are actually required. The procurement process needs to be changed to support the organizations that are operated under the Army Industrial Fund (AIF) mechanism. For example, if an organization like IMD needs a new mainframe computer, then it should be able to get it quickly. The success of an AIF operated organization like IMD, depends upon making state-of-the-art equipment available to the User. Unless, IMD is providing something that the Users want to buy at the going price, then the Users will continue to seek other alternatives. The procurement process for all goods and services needed by the S&E Community should be reviewed and improvements to the process should be made where possible.

The Users, unfortunately, are affected the most by a combination of the principal components of the problem. They are asked to perform their work with antiquated S&E Equipment. They lack sufficient quantities of the hardware and software capabilities, that would allow their Scientific and Engineering skills to be more effectively utilized. They are forced to wait unreasonable amounts of time for outputs, from relatively slow or highly saturated computers. They have to "wait in line" to use limited numbers of terminals, Engineering Workstations, printers, plotters, etc. They resent spending so much of their time coding programs, that could be bought off-the-

shelf. But, most of the time, it is faster to write the required piece of software, than to spend six months to one year trying to obtain it through procurement. Some User's projects have been held up for periods between two and four years, waiting for appropriate real-time hardware, software and telecommunications capabilities to be procured. The Users have discussed their problems and concerns with their Management, who have either tried to do something about it, or, have simply said that nothing can be done about it. The real needs of the Users never surface up to TOP MANAGEMENT for appropriate action. The User problems that are a result of the poor S&E Computing Environment at MICOM are: poor morale among members of the S&E Community, diminished and impeded productivity, negative attitudes, frustration, and, the feeling that nobody cares about their problems and nobody is going to do anything about their problems. The Users cannot effectively support their organization's missions without the proper tools: state-of-the-art hardware, software and telecommunications capabilities. If the needed capabilities were more readily provided, the Users would be less inclined to "do their own thing" and would be more inclined to use the capabilities that are readily provided. Less time would be spent trying to figure out how to obtain the S&E equipment and software needed, and more time could be spent in accomplishing MICOM's Research and Development, Scientific and Engineering Mission.

[illegible] is a problem that has existed in the Past at MICOM, and, will become a greater problem in the Future. In the Past, the training made available to the Users has been either too simple or too complicated to be useful. In some cases, the training examples used in the cookbook training courses provided have been too far removed, from the User's work environment, to be useful in providing the Users with the basic skills and insight needed,

to address simple application development tasks, in their own environment. With no place to go for help and application development assistance, the Users can flounder for months on simple technical problems. More customized training, targeted to the End-Users work environment, is needed at MICOM. In the Future, one-half to three-quarters of the 9,000 MICOM employees will need extensive ADP training provided to them. The study discovered that MICOM uses or plans to use at least 220 different software packages across the mainframe, mini and micro levels of computers. Add in the variety of different hardware vendors (over 107) and the training problem becomes very complicated. Further complicate the issue by adding in multiple levels of training (i.e., beginner, intermediate and advanced), and the problem becomes even more complicated. Pondering these thoughts for a moment and doing some quick calculations, shows that the magnitude of the training problem involves providing hundreds of thousands of training course units to somewhere between 4,500 and 6,750 MICOM employees. Training directly impacts productivity and the quality of life on the Arsenal. Significantly more emphasis needs to be placed on developing a high-quality permanently-staffed training support center at Redstone Arsenal for the benefit of the employees.

The problem of supporting the large variety of hardware, software and telecommunications capabilities, that are currently utilized by MICOM, is enormous. Providing an adequate level of support, for over 107 different hardware vendors, computers and peripheral devices, and over 220 different software capabilities, is a very complex task. In the Past, IMD has provided as much support as was possible, within their staffing capabilities, areas of expertise and budgeting limitations. The size of the S&E User Community has grown substantially over the past decade, and, the number of S&E Computer Users is expected to double or triple, over the next ten years. In the Past,

the size of the IMD S&E Support Staff has shrunk, as the requirements for support have grown sharply. The lack of staff has prevented IMD from developing any significant level of support, for a variety of software packages and programming languages, that the Users are using, or want to use in the near future. As the User Community expands, the demand for support services and the scope of those services will continue to increase. IMD needs additional budget and staff to support these anticipated needs. IMD also needs to expand the effective utilization of contractor provided support services, to improve the level of support provided to the User Community.

2.5 A Functional Analysis of the Requirements

The data collected on the Organizational Level Questionnaires regarding current and future computer applications was insufficient for further analysis, because the information provided was rather incomplete or it was not provided at all. Figures 2-43 and 2-44 tabulated the data directly from the questionnaires and showed only 96 specific applications and 72 application areas. Data captured on the User Level Questionnaires indicated the existence of over 1500 applications in many Engineering Areas. Although the data on specific applications was very weak, some useful information was developed at a functional area level, which was used to indicate current and future requirements.

Section 2.5.1 provides an analysis of the software category requirements by organizational element that responded to the Organizational Level Survey. Section 2.5.2 provides an analysis of the MACARS Specialty Areas and Engineering Areas that are supported by computer applications. It also identifies areas of work and types of analyses that require computer application support. Section 2.5.2 utilizes data which was collected on the User Level Questionnaires, which were developed when it became evident that the responses to Questions #7 and #10 on the Organizational Level Questionnaires were incomplete and inadequate for analysis. Section 2.5.3 identifies some User stated requirements. Sections 2.5.4 through 2.5.10 briefly discuss training, support, systems integration, systems conversion, telecommunications, hardware and software requirements, respectively. Additional information concerning most of these requirement areas is contained in the Volume I MANAGEMENT OVERVIEW document.

2.5.1 Software Category Requirements by Organization

The data provided in response to Question #11 on the Organizational Level Questionnaires was massaged and organized into the format provided as Figure 2-46. Figure 2-46 indicates which MICOM sub-organizations currently use or need a particular category of software package on a particular level of computer. The categories of software include: DATABASE MANAGEMENT, ENGINEERING PACKAGES, GRAPHICS, PROGRAMMING LANGUAGES, PROJECT MANAGEMENT PACKAGES, SCIENTIFIC SOFTWARE LIBRARIES, STATISTICAL ANALYSIS PACKAGES, SIMULATION/MODELING LANGUAGES, PERSONAL COMPUTER COMMUNICATIONS PACKAGES, WORD PROCESSING PACKAGES, and CAD/CAM FACTORY AUTOMATION PACKAGES. The levels of computers include: mainframes, micros and minis.

An analysis of the table shows that all eleven categories of software are required, on all three levels of hardware: mainframes, microcomputers and minicomputers, by at least a few organizational elements of the Command. A strong bias exists in the number of responses directed towards software capabilities that run on micros and minicomputers. Out of the 741 indicators developed for this exercise, 45% (332/741) were directed towards microcomputers, 30% (225/741) towards minicomputers, and 25% (184/741) towards mainframes. This indicates a very strong desire to use the minicomputer and microcomputer levels of hardware at MICOM; and, helps to explain where the S&E computer workload has migrated to.

At the mainframe level, the organizations surveyed indicated a strong need for PROGRAMMING LANGUAGES, DATABASE MANAGEMENT PACKAGES AND GRAPHICS PACKAGES. These three needs are widely distributed across MICOM organizational elements. The requirements for software packages in the Scientific Software Libraries, Simulation/Modeling, Statistical Analysis, and

Project Management Areas were indicated less frequently by the respondents. The requirements for Engineering Packages and CAD/CAM software were identified by the Functional Directorates and the larger PMOs.

At the minicomputer level, the number of organizational elements that indicated the needs for various software package capabilities increased in all categories, except for Engineering Packages, Scientific Software Libraries and Simulation/Modeling Languages. In descending order of frequency of mention, the ranking of the software package requirements at the minicomputer level is as follows: Graphics (42), Database Management (35), Programming Languages (35), Project Management (26), Word Processing (22), Statistical (18), Personal Computer Communications (15), Simulation/Modeling (10), Engineering Packages (9), Scientific Software Library (7), and CAD/CAM (6). The higher frequency of minicomputer software package requirements demonstrates a high level of interest in utilizing minicomputer processing power, across many application areas. Note, that 22 of the 52 respondents, at the minicomputer level, did not indicate any software package requirements, at the mainframe level.

At the microcomputer level, the frequency for software package requirements increased in all but two categories: Scientific Software Libraries and Simulation/Modeling Packages. The number of sub-organizations indicating any software category requirements at the micro level was 64. Out of the 64, 29 did not indicate any corresponding mainframe software package requirements; and, 25 did not indicate any corresponding minicomputer software package requirements. Database Management Packages, Word Processing Packages, Graphics Packages, Programming Languages, Personal Computer Communications Packages and Project Management Packages dominate the interest of 55% of the

organizational respondents at the micro level.

Out of the 107 Organizational Level Questionnaires that were collected, only 83 had useful information for Question #11. But, some useful statistics were derived to show that 57% (47/83) of the responsive organizational respondents are interested in mainframe software capabilities; 63% (52/83) are interested in minicomputer software capabilities and 77% (64/83) are interested in microcomputer software capabilities.

In the Past, Users have gravitated to the mini and micro levels of hardware, because of the rich variety of software capabilities that are available on these levels of machines. In the future, Users will continue to gravitate towards the levels of hardware, which support the software packages, that they want to use. After the software package is determined, the User's next priority is response time; followed by cost. IMD must consider these User Requirements, during the creation of the new S&E Computing Environment at MICOM. Modern mainframe computers are now available with larger central memory and faster CPU processor speeds, which support a wide variety of software packages that the Users are interested in using. IMD must acquire and support a variety of software packages that meets the User's needs.

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MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF THE NUMBER OF MICOM SUB ORGANIZATIONS
THAT NEED SOFTWARE PACKAGES ACROSS MAINFRAMES, MICROS AND MINIS
BY SOFTWARE CATEGORY

	SOFTWARE CATEGORY										
	1	2	3	4	5	6	7	8	9	10	11
MACHTYPE											
SUBORGCD											
MAIN											
AMCPM-ADCC-D	1	.	1	1	.	.	.	1	.	.	.
AMCPM-ADCC-ES	.	.	.	.	.	.	.	.	.	.	1
AMCPM-ADCC-S	1	.	1	1	1	.	.	.	1	.	.
AMCPM-HAEE	1	.	1	.	.	.	.	.	.	.	.
AMCPM-JM	1	1	1	.	1	1	1	1	.	.	.
AMCPM-MD-I-C	1	.	1	.	1	.	.	.	1	.	.
AMCPM-MD-M-B	1	.	1	1	.	.	.	1	1	.	.
AMCPM-MD-M-C	1	.	.	.	1	.	.	.	.	1	.
AMCPM-MD-M-R	1	.	1	1	1	.	.	.	1	.	.
AMCPM-MD-S-D	1	.	1	1	1	.	.	.	.	.	.
AMCPM-MD-S-P	1	1	1	1	.	1	1	.	.	.	.
AMCPM-MD-S-S	1	.	.	.	.	.	.	.	.	.	.
AMCPM-MPL	1	.	.	1	.	.	.	.	.	.	.
AMCPM-MPS	.	.	1	.	.	.	.	.	.	.	.
AMCPM-PE	1	1	1	1	1	1	1	1	.	1	1
AMCPM-PE-E	.	.	.	1	.	.	.	.	.	.	.
AMCPM-PE-MR	.	.	.	.	1	.	.	.	.	.	.
AMCPM-ROL	.	.	.	1	.	1	.	.	.	.	.
AMCPM-RSE	.	.	1	1	.	.	1	1	1	.	.
AMCPM-TOQ	1	.	.	.	.	.	.	.	.	.	.
AMSMI-DP	.	.	1	1	1	1	1	.	1	.	.
AMSMI-DS	.	.	1	1	.	1	1	1	.	.	.
AMSMI-EE	1	.	1	1	1	1	1	1	.	1	.
AMSMI-EG	.	1	.	1	.	.	.	1	.	.	.
AMSMI-FB	1	.	.	.	.	.	.	.	.	.	.
AMSMI-FM	1	.	1	1	.	.	.	.	.	.	.
AMSMI-FO	.	.	.	.	.	.	1	.	1	.	.
AMSMI-FX	.	.	.	.	.	.	.	.	1	.	.
AMSMI-HP	1	.	.	.	.	.	.	.	.	.	.
AMSMI-JT	1	.	1	1	1	.	1	1	.	.	.
AMSMI-QP	1	1	1	1	1	.	1	1	.	.	.
AMSMI-QRT	.	.	.	1	.	.	.	.		.	.
AMSMI-QS	1	.	1	1	.	1	1	.	.	.	.

LEGEND FOR SOFTWARE CATEGORY:

1. DATABASE MANAGEMENT
2. ENGINEERING PKGS
3. GRAPHICS
4. PROGRAMMING LANGUAGES
5. PROJECT MANAGEMENT
6. SCIENTIFIC SOFTWARE LIB
7. STATISTICAL
8. SIMULATION/MODELLING
9. PERSONAL COMPUTER COMM
10. WORD PROCESSING
11. CAD/CAM

Figure 2-46 Software Category Requirements by Sub-Organization

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF THE NUMBER OF MICOM SUB ORGANIZATIONS
THAT NEED SOFTWARE PACKAGES ACROSS MAINFRAMES, MICROS AND MINIS
BY SOFTWARE CATEGORY

	SOFTWARE CATEGORY										
	1	2	3	4	5	6	7	8	9	10	11
MACHTYPE											
SUBORGCD											
MAIN											
AMSMI-RE	.	.	.	1	.	1	.	.	.	.	.
AMSMI-RH	1	.	1	1	.	1	.	1	.	.	.
AMSMI-RK	1	1	1	1	.	1	1	.	1	.	1
AMSMI-RL	.	1	1	1	.	1	.	1	.	.	.
AMSMI-RR	.	.	1	1	.	1	.	.	.	.	.
AMSMI-SL	1	1	1	1	1	1	1	1	1	1	.
AMSMI-WSE	1	1	1	1	1	1	1	1	.	.	.
AMSMI-WSS	.	.	1	1	.	1	.	1	.	.	.
AMSMI-WST	1	1	1	1	1	1	1	1	.	.	1
AMSMI-Z	1	.	.	.	.	.	1	.	.	.	.
AMXHE-MI	.	.	1	1	.	.	.	1	.	1	.
AMXTM-CO	1	.	.	.	.	.	.	.	.	.	.
AMXTM-L	1	.	1	.	.	.	.	.	.	.	.
AMXTM-SAI	1	.	.	1	.	.	.	.	.	.	.
*TOTAL MAIN	30	10	29	31	15	17	16	17	10	5	4

LEGEND FOR SOFTWARE CATEGORY:

1. DATABASE MANAGEMENT
2. ENGINEERING PKGS
3. GRAPHICS
4. PROGRAMMING LANGUAGES
5. PROJECT MANAGEMENT
6. SCIENTIFIC SOFTWARE LIB
7. STATISTICAL
8. SIMULATION/MODELLING
9. PERSONAL COMPUTER COMM
10. WORD PROCESSING
11. CAD/CAM

Figure Z-46 Software Category Requirements by Sub-Organization (cont'd)

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MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF THE NUMBER OF MICOM SUB ORGANIZATIONS
THAT NEED SOFTWARE PACKAGES ACROSS MAINFRAMES, MICROS AND MINIS
BY SOFTWARE CATEGORY

	SOFTWARE CATEGORY										
	1	2	3	4	5	6	7	8	9	10	11
MACHTYPE											
SUBORGCD											
MICRO											
AMCPM-ADCC-A	1	.	1	1	.	.	.	.	1	1	.
AMCPM-ADCC-D	.	.	1	1	1	.	.	1	.	1	.
AMCPM-ADCC-EH	1	.	1	1	1	1	1	1	1	1	.
AMCPM-ADCC-ES	1	1	1	1	1	.	1	.	1	1	1
AMCPM-ADCC-P	1	.	.	1	1	.	1	.	1	1	.
AMCPM-AMWS	1	.	1	1	1	.	1	.	1	1	.
AMCPM-ATM	1	1	1	1	1	.	1	.	1	1	.
AMCPM-CFC	1	1	1	1	1	.	.	.	1	1	.
AMCPM-CFE	1	.	1	1	1	.	.	.	.	1	.
AMCPM-CFM	.	.	1	.	1	.	.	.	.	1	.
AMCPM-CFS	1	.	1	1	1	.	1	.	1	1	.
AMCPM-HAC	1	.	.	.	.	.	.	.	.	.	.
AMCPM-HAEE	.	.	1	1	1	.	.	.	1	1	.
AMCPM-HAO	.	.	.	.	.	.	.	.	1	1	.
AMCPM-HAQ	1	1	1	.	1	.	1	.	1	1	.
AMCPM-HDE	1	1	1	1	1	.	.	.	1	1	.
AMCPM-HDE-S	1	.	.	.	1	.	.	.	1	1	.
AMCPM-HDM-E	1	1	1	1	1	.	.	1	1	.	.
AMCPM-HDT	1	1	1	1	.	.	1	.	1	.	.
AMCPM-JM	1	.	1	1	.	1	1	1	1	1	.
AMCPM-MD-I-C	.	.	.	1	.	.	.	.	.	1	.
AMCPM-MD-M-C	1	.	.	1	.	.	.	.	.	1	.
AMCPM-MD-M-R	1	.	1	.	.	.	.	.	1	.	.
AMCPM-MD-S-D	1	.	.	.	.	.	.	.	.	.	.
AMCPM-MPE	.	.	1	.	1	.	.	.	.	1	.
AMCPM-MPL	.	.	.	.	.	.	.	.	.	1	.
AMCPM-MPM	.	.	1	.	1	.	.	.	.	.	.
AMCPM-MPS	.	.	1	.	.	.	.	.	.	1	.
AMCPM-PE	1	.	.	1	1	1	1	1	1	1	1
AMCPM-PE-E	1	.	1	1	.	.	.	.	.	1	.
AMCPM-PE-EA	1	.	.	.	.	.	.	.	1	1	.
AMCPM-PE-EG	1	.	1	.	.	.	.	.	1	1	.
AMCPM-PE-MR	1	.	1	1	.	.	.	.	.	1	.

LEGEND FOR SOFTWARE CATEGORY:

1. DATABASE MANAGEMENT
2. ENGINEERING PKGS
3. GRAPHICS
4. PROGRAMMING LANGUAGES
5. PROJECT MANAGEMENT
6. SCIENTIFIC SOFTWARE LIB
7. STATISTICAL
8. SIMULATION/MODELLING
9. PERSONAL COMPUTER COMM
10. WORD PROCESSING
11. CAD/CAM

Figure 2-46 Software Category Requirements by Sub-Organization (cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF THE NUMBER OF MICOM SUB ORGANIZATIONS
THAT NEED SOFTWARE PACKAGES ACROSS MAINFRAMES, MICROS AND MINIS
BY SOFTWARE CATEGORY

MACHTYPE / SUBORGCD	SOFTWARE CATEGORY 1	2	3	4	5	6	7	8	9	10	11
MICRO											
AMCPM-RSE	1	.	1	.	1	1	.	.	1	1	.
AMSMI-DP	1	.	1	1	1	1	1	.	1	.	.
AMSMI-EE	1	1	1	1	1	1	1	1	1	1	.
AMSMI-EG	1	1	1	1	.	1	1	1	1	1	.
AMSMI-EN	1	.	1	1	1	.	.	.	1	1	.
AMSMI-ET	1	.	1	1	1	.	.	.	1	1	1
AMSMI-FB	1	.	1	1	.	.	.	.	1	1	.
AMSMI-FM	1	.	1	1	.	.	1	.	1	1	.
AMSMI-FMMR	1	.	1	1	.	.	.	.	.	.	.
AMSMI-FO	.	.	.	.	.	.	.	.	1	.	.
AMSMI-FX	1	.	1	1	1	.	1	.	1	1	.
AMSMI-QP	1	1	1	1	1	.	.	1	.	1	.
AMSMI-QRT	.	.	.	1	.	.	.	.	.	.	.
AMSMI-QS	1	.	1	1	1	1	1	.	1	1	.
AMSMI-RE	1	.	.	1	1	.	.	.	.	1	.
AMSMI-RH	1	.	1	1	1	.	.	.	1	1	.
AMSMI-RK	1	1	1	1	1	1	1	.	1	.	1
AMSMI-RL	1	.	1	1	1	1	.	.	1	1	1
AMSMI-RO	1	.	1	1	1	1	1	.	1	1	.
AMSMI-SL	1	1	1	1	1	1	1	1	1	1	.
AMSMI-SNPA	1	.	.	1	1	.	.	.	1	1	1
AMSMI-UF	1	.	1	.	.	.	.	.	1	1	.
AMSMI-UL	1	.	.	.	.	.	.	.	.	.	.
AMSMI-UP	1	.	1	.	.	.	1	.	.	1	.
AMSMI-WSE	1	.	.	.	.	1	.	.	.	.	.
AMSMI-WSS	1	.	1	1	.	.	.	.	1	1	.
AMXHE-MI	.	.	1	1	.	.	.	1	.	1	.
AMXTM-A	1	.	1	1	1	.	.	.	.	1	.
AMXTM-CO	.	1	1	1	.	.	.	.	.	.	.
AMXTM-L	1	.	1	1	1	.	1	.	1	1	.
AMXTM-SAI	1	.	1	1	.	.	.	.	1	.	.
*TOTAL MICRO	51	13	48	45	35	13	21	10	41	49	6

LEGEND FOR SOFTWARE CATEGORY:

1. DATABASE MANAGEMENT
2. ENGINEERING PKGS
3. GRAPHICS
4. PROGRAMMING LANGUAGES
5. PROJECT MANAGEMENT
6. SCIENTIFIC SOFTWARE LIB
7. STATISTICAL
8. SIMULATION/MODELLING
9. PERSONAL COMPUTER COMM
10. WORD PROCESSING
11. CAD/CAM

Figure 2-46 Software Category Requirements by Sub-Organization (cont'd)

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MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF THE NUMBER OF MICOM SUB ORGANIZATIONS
THAT NEED SOFTWARE PACKAGES ACROSS MAINFRAMES, MICROS AND MINIS
BY SOFTWARE CATEGORY

	SOFTWARE CATEGORY										
	1	2	3	4	5	6	7	8	9	10	11
MACHTYPE											
SUBORGCD											
MINI											
AMCPM-ADCC-D	.	.	.	.	1	.	.	.	.	.	.
AMCPM-ADCC-EH	1	1	1	1	1	1	1	1	.	.	1
AMCPM-ADCC-ES	1	.	.	.	.	.	.	.	.	.	1
AMCPM-ADCC-P	1	.	1	1	.	.	.	.	1	1	.
AMCPM-ATM	1	1	1	1	1	.	1	.	1	1	.
AMCPM-CFE	.	.	1	1	.	.	.	.	.	1	.
AMCPM-CFM	.	.	.	1	.	.	.	.	.	.	.
AMCPM-CFP	1	.	1	1	.	.	.	.	.	1	.
AMCPM-CFS	1	.	1	1	1	.	1	.	1	1	.
AMCPM-HAEE	1	.	1	.	.	.	.	.	.	.	.
AMCPM-HDM-E	1	.	1	.	.	.	.	.	.	.	.
AMCPM-HDM-F	1	.	1	1	1	.	1	.	1	1	.
AMCPM-HDT	1	1	1	1	1	.	1	.	.	.	.
AMCPM-JM	1	.	1	1	1	.	1	1	.	.	.
AMCPM-MD-I-C	.	.	1	.	.	.	.	.	.	.	.
AMCPM-MD-M-B	.	.	.	.	.	.	.	.	.	1	.
AMCPM-MD-M-C	1	.	1	.	.	.	.	.	.	.	.
AMCPM-MD-S-D	1	.	1	1	1	.	.	.	1	.	.
AMCPM-MD-S-P	.	.	1	.	.	.	.	.	.	.	.
AMCPM-MD-S-S	.	.	1	1	.	.	.	.	.	.	.
AMCPM-MPE	.	.	1	.	1	.	.	.	.	.	.
AMCPM-MPL	1	.	1	1	1	.	.	.	.	.	.
AMCPM-MPP	1	.	1	1	1	.	1	1	1	1	.
AMCPM-MPT	1	.	1	.	1	.	.	.	.	1	.
AMCPM-PE	1	.	.	.	.	.	.	.	.	.	.
AMCPM-ROL	1	.	1	1	.	.	.	.	.	1	.
AMCPM-RSE	.	.	1	1	.	.	1	.	1	.	.
AMCPM-TOE	1	1	1	.	1	.	1	.	.	1	.
AMCPM-TOQ	1	.	1	.	.	.	.	.	.	1	.
AMSMI-DP	1	.	1	1	1	1	1	.	1	.	.
AMSMI-DS	.	.	.	.	.	.	.	1	.	1	.
AMSMI-EE	.	.	1	1	1	1	1	1	.	1	.
AMSMI-EG	1	.	.	1	1	.	.	.	.	1	.

LEGEND FOR SOFTWARE CATEGORY:

1. DATABASE MANAGEMENT
2. ENGINEERING PKGS
3. GRAPHICS
4. PROGRAMMING LANGUAGES
5. PROJECT MANAGEMENT
6. SCIENTIFIC SOFTWARE LIB
7. STATISTICAL
8. SIMULATION/MODELLING
9. PERSONAL COMPUTER COMM
10. WORD PROCESSING
11. CAD/CAM

Figure 2-46 Software Category Requirements by Sub-Organization (cont'd)

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF THE NUMBER OF MICOM SUB ORGANIZATIONS
THAT NEED SOFTWARE PACKAGES ACROSS MAINFRAMES, MICROS AND MINIS
BY SOFTWARE CATEGORY

	SOFTWARE CATEGORY										
	1	2	3	4	5	6	7	8	9	10	11
MACHTYPE / SUBORGCD											
MINI											
AMSMI-EP	1	1	1	1	1	1	1	1	1	1	1
AMSMI-ET	1	.	1	1	1	.	.	1	1	1	1
AMSMI-FMMR	1	1	1	1	.	.	.	.	.	1	.
AMSMI-FX	1	.	1	1	1	.	1	.	1	1	.
AMSMI-HP	1	.	1	.	.	.	.	.	.	.	.
AMSMI-QP	.	.	.	1	1	.	.	1	.	.	.
AMSMI-QRT	.	.	.	1	.	.	.	.	.	.	.
AMSMI-QS	1	.	1	1	1	.	.	.	.	.	.
AMSMI-RE	.	.	1	1	.	.	.	.	.	.	.
AMSMI-RH	1	.	1	1	1	.	.	.	1	1	.
AMSMI-RK	.	1	1	1	.	.	1	.	.	.	1
AMSMI-RL	1	1	1	1	1	1	.	.	.	.	1
AMSMI-SL	1	1	1	1	1	1	1	1	1	1	.
AMSMI-SNPA	1	.	.	.	.	.	.	.	.	.	.
AMSMI-UF	.	.	1	.	.	.	.	.	.	.	.
AMSMI-UL	1	.	1	1	1	.	1	1	1	1	.
AMSMI-US	1	.	1	1	.	.	1	.	.	.	.
AMSMI-WSS	.	.	1	1	.	.	.	.	.	.	.
AMXTM-SAI	1	.	1	1	1	1	1	.	1	.	.
*TOTAL MINI	35	9	42	35	26	7	18	10	15	22	6

LEGEND FOR SOFTWARE CATEGORY:

1. DATABASE MANAGEMENT
2. ENGINEERING PKGS
3. GRAPHICS
4. PROGRAMMING LANGUAGES
5. PROJECT MANAGEMENT
6. SCIENTIFIC SOFTWARE LIB
7. STATISTICAL
8. SIMULATION/MODELLING
9. PERSONAL COMPUTER COMM
10. WORD PROCESSING
11. CAD/CAM

Figure 2-46 Software Category Requirements by Sub-Organization (cont'd)

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MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
COUNT OF THE NUMBER OF MICOM SUB ORGANIZATIONS
THAT NEED SOFTWARE PACKAGES ACROSS MAINFRAMES, MICROS AND MINIS
BY SOFTWARE CATEGORY

MACHTYPE / SUBORGCD	SOFTWARE CATEGORY 1	2	3	4	5	6	7	8	9	10	11
TOTAL	116	32	119	111	76	37	55	37	66	76	16

LEGEND FOR SOFTWARE CATEGORY:

1. DATABASE MANAGEMENT
2. ENGINEERING PKGS
3. GRAPHICS
4. PROGRAMMING LANGUAGES
5. PROJECT MANAGEMENT
6. SCIENTIFIC SOFTWARE LIB
7. STATISTICAL
8. SIMULATION/MODELLING
9. PERSONAL COMPUTER COMM
10. WORD PROCESSING
11. CAD/CAM

Figure 2-46 Software Category Requirements by Sub-Organization (cont'd)

2.5.2 Application Area Requirements by Organizations

The data collected on the User Level Questionnaires established the fact that all MACARS Specialty Areas are supported, directly or indirectly, by computer applications. Figure 2-47 indicates which MACARS Specialty Areas are supported, by computer applications, in which major MICOM organizations. Figure 2-47 was developed using the responses to the second part of Question #5 on the User Level Questionnaires. It is believed, that if a larger and more diversified distribution of User Level Questionnaires had been collected, that more Users would have indicated a greater variety of areas that are supported by computer applications in each organization. But, Figure 2-47 still indicates that a wide variety of S&E Applications exist across MICOM organizations. Figure 2-48 was developed using the responses to Question #5 on the Organizational Level Questionnaires. Figure 2-48 shows which organizations are likely to have computer applications requirements, in various MACARS Areas, based upon the current or planned existence of manpower requirements in various categories. A careful comparative review of Figures 2-47 and 2-48, shows that within many organizations, a wider variety of MACARS Areas may be supported by computer applications. For most organizations who provided MACARS manpower distributions, the categories indicated in Figure 2-48 can be used to enhance the variety of categories identified by the User provided data.

Figures 2-49 and 2-50 aggregate the data provided in response to Question #5 on the Organizational Level Questionnaires. Question #5 captured data on the Engineering manpower support requirements for an organization by Engineering Discipline and by MACARS Specialty Area. Although many organizations did not provide accurate and complete data for Question #5 (the data represents only about 10% of the current MICOM staff), the data

aggregations still show a wide dispersion of manpower across many Engineering Disciplines and MACARS Areas. If one assumes that all MACARS Areas are supported by Computer Applications; that individuals in all MACARS Areas work on computers now or will do some work on computers in the long-term; and, that all MACARS Specialty Areas are directly related to one or more Engineering Disciplines; then, it can be argued that growth in the manpower required in various Engineering Disciplines and MACARS Specialty Areas can be used to infer growth in the number of computer applications required. Since growth is expected in the manpower requirements, a corresponding growth in the number of S&E computer applications is also expected.

Figure 2-51 shows which organizations have Computer Applications Requirements in various Engineering Areas. Figure 2-51 was developed using the data collected on the User Level Questionnaires for Question #5. Figure 2-52 shows which organizations have potential Computer Applications Requirements in various Engineering Areas. Figure 2-52 was developed using the data collected on the Organizational Level Questionnaires for Question #5.

Figures 2-53 and 2-54 represent composite profiles of the existence of Computer Applications Requirements in various MICOM Organizations. Figure 2-53 is a combination of Figures 2-47 and 2-48; and, Figure 2-54 is a combination of Figures 2-51 and 2-52. Figures 2-53 and 2-54 more accurately depict the variety of work that is performed in each organization. They also can be used to make the assessment that a larger number of S&E Applications currently exist and more will exist in the future. For example, if there existed only ten applications for each category flagged for each organization in Figure 2-53, an estimate of 4150 applications could be developed by taking the 415 indicators and multiplying by 10. Likewise, if only ten applications

are developed, in each flagged area, over the next ten years, then the estimated number of future applications would be 4150. Although the data collected on the number of current and future applications is not very accurate, Figures 2-53 and 2-54 accurately point to some specific areas, which are currently supported by computer applications or will be in the future. Both figures clearly picture the depth and breadth of the S&E Requirements that exist across MICOM organizations.

Figures 2-55 and 2-56 demonstrate a variety of the types of S&E work and analyses that are performed at MICOM. These lists were developed to show who does what in the S&E Arena. These lists are not 100% complete, but they represent the information gathered. Figure 2-55 shows some of the work performed by the Army Missile Laboratories, broken down by directorate. Figure 2-56 shows some of the work performed in the Systems Engineering and Production Directorate and in the Product Assurance Directorate. These three major MICOM organizations perform a bulk of the real S&E work at MICOM. Sufficient time was not available, during the course of the study, to perform a similar analysis for all 25 MICOM organizations.

It is believed that most, if not all, of the S&E Areas depicted in Figures 2-47 through 2-56 are supported by some computer applications now; and, future computer support is required in all these areas. The application areas are expanding, the complexity of the work is growing, and so is the need for adequate computing facilities to handle the S&E Workload.

[illegible] SCIENTIFIC AND ENGINEERING SUPPORTING REQUIREMENTS ANALYSIS

TABULATION OF ORGANIZATIONS THAT HAVE COMPUTER APPLICATIONS
SUPPORTING MACARS SPECIALTY AREAS

AREANAME	HEADCD 1	2	3	4	6	7	9	10	13	14	17	18	19	20	21	22	23	24	25
AUTOMATIC TEST EQUIPMENT	.	1	1	.	.	.	.	.	1	1	.	.	.	.	.	1	1	.	.
BUDGET & ACCOUNTING	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CHEMISTRY	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
COMMAND AND CONTROL COMMUNICATIONS	.	1	1	.	.	.	.	.	1	1	.	1	.	.	.	.	1	.	.
COMPUTERS	.	1	1	1	1	.	.	.	1	1	1	1	1	.	1	1	1	.	.
CONFIGURATION MANAGEMENT	.	1	1	1	.	1	.	.	.	1	1	1	.	1	1	1	1	1	1
COST AND SCHEDULE ANALYSIS	1	1	1	1	1	.	1	.	1	.	1	1	.	1	1	1	1	1	1
ELECTRO-MAGNETIC RADIATION	.	1	1	.	.	.	.	.	.	1	.	1	.	.	.	.	1	.	.
ELECTRONIC COMPONENTS	.	1	1	.	.	1	.	.	.	1	.	1	.	.	.	1	1	.	.
FACILITIES MANAGEMENT	.	1	.	1	.	1	.	.	.	1	.	.	.	.	.	1	.	.	.
FIRE CONTROL	.	.	1	.	.	1	.	.	1	1	.	1	.	.	.	1	.	.	.
GENERAL ENGINEERING	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
GROUND SUPPORT EQUIPMENT	.	1	1	1	.	1	.	.	1	1	1	1	.	.	.	1	.	.	1
GUIDANCE AND CONTROL	.	.	1	1	.	.	.	.	1	1	.	1	.	.	.	1	.	.	.
HUMAN FACTOR ENGINEERING	.	1	1	.	.	1	.	.	.	.	.	1	.	.	.	1	.	.	.
INDUSTRIAL/MANAGEMENT ENGINEERING	.	1	1	.	.	1	.	.	.	1	1	1	1	.	1	1	.	1	.
INFARED AND ELECTRO-OPTICAL SENSOR	.	1	1	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.
INSTRUMENTATION	.	1	1	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.
LASERS	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
MATERIALS	.	1	1	.	.	.	.	.	.	1	.	1	.	.	.	1	.	.	.
MATHEMATICS	.	1	1	1	1	.	.	.	1	1	1	1	1	.	1	1	1	.	.
METROLOGY	.	.	1	.	.	.	.	.	1	1	.	1	.	.	.	.	1	.	.
MISSILE DYNAMICS	1	1	1	1	.	1	.	.	1	1	1	1	.	.	.	1	.	.	.
NUCLEAR EFFECTS	.	1	1	.	.	.	.	.	.	1	.	1	.	.	.	1	.	.	.
OPERATIONS RESEARCH	.	1	1	.	1	.	.	1	1	1	1	1	1	.	1	1	1	1	1
OPTICS	.	1	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
PARTICAL BEAM	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
PRODUCT ASSURANCE	.	1	1	1	.	1	.	.	1	1	.	1	1	1	.	1	.	1	1
PROPULSION	1	.	1	.	.	.	.	.	.	1	.	1	.	.	.	1	.	.	.
RADAR	.	1	1	.	.	1	.	.	1	1	.	.	.	.	.	.	.	.	.
RISK ANALYSIS	1	1	1	1	.	1	.	.	1	1	1	1	.	.	1	.	1	1	1
SAFETY ENGINEERING AND MANAGEMENT	.	1	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.
SEEKERS	.	.	1	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.
STRUCTURES	.	.	1	.	.	1	.	.	1	1	.	1	.	.	.	1	.	.	.
SYSTEMS	.	1	1	.	.	.	.	.	1	1	.	1	.	.	.	1	.	.	.
SYSTEMS DESIGN AND DEVELOPEMENT	1	1	1	.	.	.	.	.	1	1	.	1	.	.	.	1	1	.	.
SYSTEMS SIMULATION	1	1	1	.	.	1	.	.	1	1	.	1	.	.	1	1	.	.	.
TARGETS	.	.	1	.	.	1	.	.	1	1	.	1	.	.	.	.	.	.	.
TECHNICAL ILLUSTRATIONS	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
TECHNICAL PUBLICATIONS	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
TELEMETRY	.	1	1	.	.	1	.	.	1	.	.	1	.	.	.	.	.	.	.
TEST AND EVALUATION	1	1	1	.	.	1	.	.	1	.	.	1	.	1	.	1	1	1	1
WARHEAD ENGINEERING	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TOTAL	7	28	37	10	5	17	1	1	23	34	10	29	5	4	8	23	13	7	7

LEGEND FOR HEADCD

1.ADV MP WPN SYS PROJ OFC	2.AIR DEF COM/CON PROJ OFC	3.ARMY MISS LAB	4.CHAP/FARE PROJ OFC
5.CIV OFC TNG MGT DIV	6.CMPT	7.HAWK PROJ OFC	8.HELLFIRE/GLD PROJ OFC
9.INT LOG SUPP OFC	10.INTNAT LOG DIR	11.JNT ATAC MISS PROJ OFC	12.JTACMS PROJ OFC
13.MGT INFO SYST DIR	14.MISS LOG CNTR	15.MISS SYS READ DIR	16.MLRS PROJ OFC
17.PATRIOT PROJ OFC	18.PERSHING PROJ OFC	19.PROD ASSUR DIR	20.STINGER PROJ OFC
21.SYST ANAL EVAL OFC	22.SYS-ENG PROD DIR	23.TMDE SUPP GR	24.TOW PROJ OFC
25.US ROLAND PROJ OFC			

Figure 2-47 MACARS Areas Supported by Computer Applications by Organization

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
ORGANIZATIONS THAT HAVE POTENTIAL COMPUTER APPLICATIONS REQUIREMENTS
BASED UPON MANPOWER REQUIREMENTS IN MACARS SPECIALTY AREAS

AREANAME	HEADCD 1	2	4	6	7	8	9	10	11	12	13	14	17	18	19	20	21	22	23	24	25
AUTOMATIC TEST EQUIPMENT	1	1	.	.	.	1	.	.	1	1	.	.	.	1	.	.	.	1	1	1	1
CHEMISTRY	.	.	.	.	1	.	.	.	1	.	.	.	.	1	.	.	.	1	.	.	.
COMMAND AND CONTROL COMMUNICATIONS	.	1	.	.	.	.	.	.	1	1	.	.	.	1	.	.	.	.	.	1	.
COMPUTERS	1	1	1	1	1	.	.	.	1	.	1	1	.	1	1	.	1	1	1	1	.
CONFIGURATION MANAGEMENT	1	1	1	.	1	1	.	1	1	1	.	.	1	1	.	1	1	1	.	1	1
COST AND SCHEDULE ANALYSIS	1	1	1	.	1	1	1	.	1	1	.	.	1	1	.	1	1	1	.	1	.
ELECTRO-MAGNETIC RADIATION	.	.	.	.	.	1	.	.	1	.	.	.	.	1	.	.	.	.	.	1	1
ELECTRONIC COMPONENTS	.	1	.	.	1	1	.	.	1	.	.	.	.	1	.	.	.	1	.	1	1
FIRE CONTROL	.	1	.	.	1	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1
GROUND SUPPORT EQUIPMENT	.	1	.	.	1	1	.	.	1	.	.	.	.	1	1	.	.	1	.	1	1
GUIDANCE AND CONTROL	1	1	.	.	1	1	.	.	1	1	.	.	.	1	.	.	.	.	.	1	1
HUMAN FACTOR ENGINEERING	.	1	1	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	1	1
INDUSTRIAL/MANAGEMENT ENGINEERING	.	1	1	.	1	1	.	.	1	.	.	1	1	1	1	1	1	1	1	.	1
LASERS	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
MATERIALS	.	.	.	.	.	1	.	.	1	.	.	.	.	1	.	.	.	1	.	.	.
MATHEMATICS	.	1	.	1	.	.	.	.	1	.	1	.	.	.	.	.	1	1	1	.	.
METROLOGY	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	1	.	.
MISSILE DYNAMICS	.	.	1	.	1	1	.	.	1	1	.	.	.	1	.	.	.	1	.	.	.
NUCLEAR EFFECTS	.	1	.	.	.	.	.	.	1	1	.	.	.	1	.	.	.	.	.	.	.
OPERATIONS RESEARCH	.	.	.	1	.	.	.	.	1	1	.	1	.	1	.	1	1	1	1	.	.
OPTICS	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
PARTICAL BEAM	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
PRODUCT ASSURANCE	1	1	.	.	1	1	.	.	1	1	.	1	.	1	1	1	.	1	.	1	1
PROPULSION	.	.	1	.	1	1	.	.	1	.	.	.	.	1	.	.	.	1	.	.	1
RADAR	.	1	1	.	1	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	1
RISK ANALYSIS	.	1	.	.	1	.	.	.	1	.	.	.	.	.	.	.	1	1	.	.	.
SAFETY ENGINEERING AND MANAGEMENT	.	1	.	.	1	1	.	.	1	.	.	.	.	1	.	.	.	1	.	.	.
SEEKERS	.	.	1	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
SYSTEMS DESIGN AND DEVELOPEMENT	.	1	1	.	.	1	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.
SYSTEMS SIMULATION	.	1	.	.	1	1	.	.	1	1	.	.	.	1	.	.	1	1	.	.	1
SYSTEMS	.	1	1	.	1	.	.	.	1	1	.	.	.	1	.	.	.	1	.	.	1
TARGETS	.	.	1	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
TELEMETRY	.	.	1	.	1	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	1
TEST AND EVALUATION	1	1	1	.	1	1	.	.	1	1	.	.	.	1	.	1	.	1	.	1	1
FACILITIES MANAGEMENT	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.
INSTRUMENTATION	.	.	.	.	.	1	.	.	1	.	.	.	.	1	.	.	.	1	.	.	.
INFARED AND ELECTRO-OPTICAL SENSOR	.	.	1	.	.	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1
STRUCTURES	.	.	1	.	1	1	.	.	1	1	.	.	.	.	.	.	.	1	.	.	.
ADMINISTRATIVE SUPPORT FOR ENGINEE	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PUBLICATION PREPARATION	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
ELECTRICAL EQUIPMENT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
WARHEAD ENGINEERING	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TOTAL	7	23	16	3	23	26	1	1	38	17	2	5	3	26	5	6	8	23	7	12	19

LEGEND FOR HEADCD

1.ADV MP WPN SYS PROJ OFC	2.AIR DEF COM/CON PROJ OFC	3.ARMY MISS LAB	4.CHAP/FAAR PROJ OFC
5.CIV OFC TNG MGT DIV	6.CMPT	7.HAWK PROJ OFC	8.HELLFIRE/GLD PROJ OFC
9.INT LOG SUPP OFC	10.INTMAT LOG DIR	11.JNT ATAC MISS PROJ OFC	12.JTACMS PROJ OFC
13.MGT INFO SYST DIR	14.MISS LOG CNTR	15.MISS SYS READ DIR	16.MLRS PROJ OFC
17.PATRIOT PROJ OFC	18.PERSHING PROJ OFC	19.PROD ASSUR DIR	20.STINGER PROJ OFC
21.SYST ANAL EVAL OFC	22.SYS-ENG PROD DIR	23.TMDE SUPP GR	24.TOW PROJ OFC
25.US ROLAND PROJ OFC			

Figure 2-48 MACARS Area Implicitly Supported by Computer Applications

MICOM SCIENTFIC AND ENGINEERING COMPUTER REQUIREMENTS ANALYSIS
ANALYSIS OF MANPOWER SUPPORT REQUIREMENTS
EQUIVALENT MANYEARS BY ENGINEERING DISCIPLINE

ENGINEERING DISCIPLINE	HEADQRGCD AMCPM CURRENT	AMCPM NEAR TERM	AMCPM LONG TERM	AMSMI CURRENT	AMSMI NEAR TERM	AMSMI LONG TERM	AMXTM CURRENT	AMXTM NEAR TERM	AMXTM LONG TERM
AEROSPACE AND AERONAUTICAL ENGINEERING	21	16	16	78	85	97	.	.	.
CHEMICAL ENGINEERING	3	4	3	7	8	8	.	.	.
CIVIL ENGINEERING	.	.	.	1	1	1	.	.	.
COMPUTER SCIENCE	8	15	21	30	41	31	12	16	17
ELECTRICAL AND ELECTRONICS ENGINEERING	60	67	61	189	195	208	15	15	15
FIRE PROTECTION ENGINEERING	1	1	1	.	.	.	.	.	.
HUMAN FACTORS ENGINEERING	5	7	7	0	1	2	2	2	3
INDUSTRIAL ENGINEERING	33	42	40	27	39	51	2	2	3
MATERIAL SCIENCE ENGINEERING	6	7	7	7	7	7	.	.	.
MECHANICAL ENGINEERING	36	41	38	92	97	110	3	3	3
MEDICAL ENGINEERING	1	1	1	.	.	.	.	.	.
NUCLEAR ENGINEERING	4	4	4	1	1	1	.	.	.
STRUCTURAL ENGINEERING	8	8	9	2	3	3	.	.	.
GENERAL ENGINEERING	74	66	56	138	163	177	8	8	8
LOGISTICS ENGINEERING	1	2	2	105	147	148	.	.	.
DATABASE MANAGEMENT	.	.	.	14	14	19	.	.	.
UNIVERSAL TEST EQUIPMENT	4	4	4	8	11	12	.	.	.
PROGRAM ANALYSIS	.	.	.	4	3	3	.	.	.
OPERATIONS RESEARCH ANALYSIS-COST ANAL	.	.	.	1	0	0	.	.	.
LASER MODELING	2	2	2	17	19	24	.	.	.
LASER PROPAGATION	1	1	1	.	.	.	.	.	.
PROJECT MANAGMENT RISK ANALYSIS	11	16	16	.	.	.	.	.	.
PHYSICS	2	2	2	7	7	7	14	14	14
ORSA SUPPORT-METROLOGY	.	.	.	1	1	1	.	.	.
MATH & STATISTICAL ANALYSIS	.	.	.	4	4	0	.	.	.
BUDGET AND ACCOUNTING	.	.	.	2	2	4	.	.	.
ELECTRONICS ENGINEERING	2	2	2	.	.	.	.	.	.
WEAPON SYSTEMS ANALYSIS	4	4	4	.	.	.	.	.	.
CONFIGURATION MANAGEMENT	2	2	2	.	.	.	.	.	.
LOGISTICS MANAGEMENT	2	2	2	.	.	.	.	.	.
COST ANALYSIS AND BUDGETING	1	1	1	.	.	.	.	.	.
ELECTRO-OPTICAL ANALYSIS	.	.	.	40	40	40	.	.	.
RADAR SPECIALIST	2	0	0	.	.	.	.	.	.
OPTICAL ENGINEERING	.	.	.	1	1	1	.	.	.
CHEMISTRY	.	.	.	4	4	4	.	.	.
TOTAL	294	317	302	780	894	959	56	60	63

Figure 2-49 Manpower Staff Requirements by Engineering Areas

MICOM SCIENTIFIC AND ENGINEERING COMPUTER REQUIREMENTS ANALYSIS
ENGINEERING MANPOWER SUPPORT REQUIREMENTS
EQUIVALENT MANYEARS BY MACARS SPECIALTY AREA

MACARS SPECIALTY AREA	HEADORGCD AMCPM CURRENT	AMCPM NEAR TERM	AMCPM LONG TERM	AMSMI CURRENT	AMSMI NEAR TERM	AMSMI LONG TERM	AMXTM CURRENT	AMXTM NEAR TERM	AMXTM LONG TERM
AUTOMATIC TEST EQUIPMENT	15	9	11	5	10	15	3	5	10
CHEMISTRY	1	4	13	2	3	4	.	.	.
COMMAND AND CONTROL COMMUNICAT	9	16	22	.	.	.	.	.	.
COMPUTERS	18	40	69	20	23	23	9	13	13
CONFIGURATION MANAGEMENT	34	34	37	23	32	42	.	.	.
COST AND SCHEDULE ANALYSIS	29	30	42	51	56	67	.	.	.
ELECTRO-MAGNETIC RADIATION	4	3	4	.	.	.	.	.	.
ELECTRONIC COMPONENTS	14	12	17	5	7	10	.	.	.
FIRE CONTROL	9	7	10	.	.	.	.	.	.
GROUND SUPPORT EQUIPMENT	15	14	13	10	12	16	.	.	.
GUIDANCE AND CONTROL	26	24	26	.	.	.	.	.	.
HUMAN FACTOR ENGINEERING	7	9	2	.	.	.	.	.	.
INDUSTRIAL/MANAGEMENT ENGINEER	30	30	30	55	68	79	1	1	1
LASERS	5	2	3	.	.	.	.	.	.
MATERIALS	6	6	6	6	8	11	.	.	.
MATHEMATICS	0	0	1	38	41	47	1	1	2
METROLOGY	0	0	0	1	1	1	4	4	4
MISSILE DYNAMICS	13	13	16	0	0	0	.	.	.
NUCLEAR EFFECTS	3	4	5	.	.	.	.	.	.
OPERATIONS RESEARCH	3	6	10	23	78	23	6	7	8
OPTICS	4	1	2	.	.	.	.	.	.
PARTICAL BEAM	0	1	2	.	.	.	.	.	.
PRODUCT ASSURANCE	36	35	39	66	72	77	.	.	.
PROPULSION	24	25	24	0	0	0	.	.	.
RADAR	7	9	11	.	.	.	.	.	.
RISK ANALYSIS	1	2	3	8	9	10	.	.	.
SAFETY ENGINEERING AND MANAGEM	1	2	3	5	6	7	.	.	.
SEEKERS	23	21	18	.	.	.	.	.	.
SYSTEMS DESIGN AND DEVELOPEMEN	36	28	31	11	14	19	.	.	.
SYSTEMS SIMULATION	4	6	9	7	9	11	.	.	.
SYSTEMS	8	9	12	7	10	15	.	.	.
TARGETS	2	3	4	.	.	.	.	.	.
TELEMETRY	4	8	6	.	.	.	.	.	.
TEST AND EVALUATION	28	36	32	8	11	16	.	.	.
FACILITIES MANAGEMENT	0	1	1	10	15	20	.	.	.
INSTRUMENTATION	2	4	5	5	7	9	.	.	.
INFARED AND ELECTRO-OPTICAL SE	9	7	5	.	.	.	.	.	.
STRUCTURES	7	7	3	3	4	6	.	.	.
ADMINISTRATIVE SUPPORT FOR ENG	1	1	1	.	.	.	.	.	.
PUBLICATION PREPARATION	0	0	0	2	2	0	.	.	.
ELECTRICAL EQUIPMENT	.	.	.	.	.	.	4	4	4
WARHEAD ENGINEERING	1	0	0	.	.	.	.	.	.
TOTAL	439	469	548	371	498	528	28	35	42

Figure 2-50 Manpower Staff Requirements by MACARS Specialty Area

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
ORGANIZATIONS THAT HAVE COMPUTER APPLICATIONS REQUIREMENTS IN ENGINEERING AREAS
BASED UPON AN ANALYSIS USER-LEVEL PROVIDED DATA

ENGEERINGNM	HEADCD 1	2	3	6	7	9	10	13	14	17	18	19	21	22	23	24	25
AEROSPACE AND AERONAUTICAL ENGINEE	1	.	1	.	.	.	.	1	.	.	1	.	.	1	.	.	1
CHEMICAL ENGINEERING	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CIVIL ENGINEERING	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.
COMPUTER SCIENCE	.	1	1	1	.	.	.	1	1	1	1	.	.	1	.	.	.
ELECTRICAL AND ELECTRONICS ENGINEE	.	1	1	.	1	.	.	.	1	.	1	.	.	1	.	1	1
FIRE PROTECTION ENGINEERING	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
HUMAN FACTORS ENGINEERING	.	1	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.
INDUSTRIAL ENGINEERING	.	1	1	.	.	.	.	.	1	1	.	1	1	1	.	.	.
MATERIAL SCIENCE ENGINEERING	.	.	1	.	.	.	.	.	1	.	1	.	.	1	.	.	.
MECHANICAL ENGINEERING	.	1	1	.	.	.	.	1	1	.	1	.	.	1	.	.	.
NUCLEAR ENGINEERING	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
STRUCTURAL ENGINEERING	.	.	1	.	.	.	.	1	1	.	1	.	.	1	.	.	.
GENERAL ENGINEERING	.	.	.	.	1	.	.	.	.	1	.	.	.	1	.	.	.
DATABASE MANAGEMENT	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
UNIVERSAL TEST EQUIPMENT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
OPERATIONS RESEARCH ANALYSIS-COST	.	1	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.
LASER MODELING	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
LASER PROPAGATION	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PROJECT MANAGMENT RISK ANALYSIS	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
PHYSICS	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ORSA SUPPORT-METROLOGY	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
MATH & STATISTICAL ANALYSIS	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
BUDGET AND ACCOUNTING	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
WEAPON SYSTEMS ANALYSIS	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
CONFIGURATION MANAGEMENT	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.
LOGISTICS MANAGEMENT	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
COST ANALYSIS AND BUDGETING	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
ELECTRO-OPTICAL ANALYSIS	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
OPTICAL ENGINEERING	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
PUBLICATION PREPARATION	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
VALUE ENGINEERING	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
FACILITIES ENGINEERING	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
MANUFACTURING ENGINEERING	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
INDUSTRIAL AUTOMATION ENGINEERING	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
IMAGE PROCESSING	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PROPERTY MANAGEMENT	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ANALYTICAL CHEMISTRY	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TECHNOLOGY DATABASE MANAGEMENT	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.
TECHNICAL ILLUSTRATIONS	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
RELIABILITY AVAILABILITY MAINTAINA	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
AUTOMATED CALIBRATION	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
RADAR	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
BUSINESS APPLICATIONS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
TOTAL	1	7	18	3	3	1	1	7	10	4	7	1	4	17	1	2	2

LEGEND FOR HEADCD

1.ADV MP WPN SYS PROJ OFC	2.AIR DEF COM/CON PROJ OFC	3.ARMY MISS LAB	4.CHAP/FAAR PROJ OFC
5.CIV OFC TNG MGT DIV	6.CMPT	7.HAWK PROJ OFC	8.HELLFIRE/GLD PROJ OFC
9.INT LOG SUPP OFC	10.INTMAT LOG DIR	11.JNT ATAC MISS PROJ OFC	12.JTACMS PROJ OFC
13.MGT INFO SYST DIR	14.MISS LOG CNTR	15.MISS SYS READ DIR	16.MLRS PROJ OFC
17.PATRIOT PROJ OFC	18.PERSHING PROJ OFC	19.PROD ASSUR DIR	20.STINGER PROJ OFC
21.SYST ANAL EVAL OFC	22.SYS-ENG PROD DIR	23.TMDE SUPP GR	24.TOW PROJ OFC
25.US ROLAND PROJ OFC			

Figure 2-51 Engineering Areas Computer Application Requirements by Organization

NICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
ORGANIZATIONS THAT HAVE POTENTIAL COMPUTER APPLICATIONS REQUIREMENTS
BASED UPON MANPOWER REQUIREMENTS IN ENGINEERING AREAS

ENGEERINGNM	HEADCD 1	2	3	4	6	7	8	10	12	13	14	15	16	17	18	19	20	22	23	24	25
AEROSPACE AND AERONAUTICAL ENGINEE	1	.	1	.	.	.	1	.	1	1	.	.	1	.	1	1	1	1	.	.	.
CHEMICAL ENGINEERING	1	.	1	.	.	1	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.
CIVIL ENGINEERING	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
COMPUTER SCIENCE	1	.	1	.	.	1	1	.	.	.	1	.	.	.	1	1	.	1	1	1	.
ELECTRICAL AND ELECTRONICS ENGINEE	1	1	1	.	.	1	1	.	1	.	1	.	1	.	1	1	1	1	1	1	1
FIRE PROTECTION ENGINEERING	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
HUMAN FACTORS ENGINEERING	1	1	.	.	.	.	1	.	.	.	.	.	.	.	1	1	.	.	1	1	.
INDUSTRIAL ENGINEERING	1	.	1	.	.	1	1	.	1	.	1	.	1	1	1	1	.	1	1	1	1
MATERIAL SCIENCE ENGINEERING	1	.	1	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.
MECHANICAL ENGINEERING	1	1	1	.	.	1	1	.	1	.	.	.	.	.	1	1	1	1	1	1	1
MEDICAL ENGINEERING	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
NUCLEAR ENGINEERING	.	1	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.
STRUCTURAL ENGINEERING	1	.	.	.	.	.	1	.	.	1	.	.	.	.	1	.	.	1	.	1	.
GENERAL ENGINEERING	.	1	1	1	.	1	1	.	.	1	.	1	1	.	.	.	1	1	1	.	1
LOGISTICS ENGINEERING	.	.	1	.	.	.	.	1	.	.	1	.	.	.	.	.	1	.	.	.	.
DATABASE MANAGEMENT	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
UNIVERSAL TEST EQUIPMENT	.	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PROGRAM ANALYSIS	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
OPERATIONS RESEARCH ANALYSIS-COST	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
LASER MODELING	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
LASER PROPAGATION	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PROJECT MANAGMENT RISK ANALYSIS	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PHYSICS	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.
ORSA SUPPORT-METROLOGY	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
MATH & STATISTICAL ANALYSIS	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
BUDGET AND ACCOUNTING	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
ELECTRONICS ENGINEERING	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
WEAPON SYSTEMS ANALYSIS	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CONFIGURATION MANAGEMENT	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
LOGISTICS MANAGEMENT	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
COST ANALYSIS AND BUDGETING	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ELECTRO-OPTICAL ANALYSIS	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
RADAR SPECIALIST	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
OPTICAL ENGINEERING	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CHEMISTRY	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TOTAL	11	7	16	1	4	6	16	1	4	4	6	1	5	1	11	8	5	8	7	7	4

LEGEND FOR HEADCD

1.ADV HP VPM SYS PROJ OFC	2.AIR DEF CON/COM PROJ OFC	3.ARMY MISS LAB	4.CHAP/FAAR PROJ OFC
5.CIV OFC TMG MGT DIV	6.CMPT	7.HAWK PROJ OFC	8.HELLFIRE/GLD PROJ OFC
9.INT LOG SUPP OFC	10.INTMAT LOG DIR	11.JNT ATAC MISS PROJ OFC	12.JTACMS PROJ OFC
13.MGT INFO SYST DIR	14.MISS LOG CNTR	15.MISS SYS READ DIR	16.MLRS PROJ OFC
17.PATRIOT PROJ OFC	18.PERSHING PROJ OFC	19.PROD ASSUR DIR	20.STINGER PROJ OFC
21.SYST ANAL EVAL OFC	22.SYS-ENG PROD DIR	23.TMDE SUPP GR	24.TOW PROJ OFC
25.US ROLAND PROJ OFC			

Figure 2-52 Potential Computer Applications Requirements by Engineering Area by Organization

MICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
ORGANIZATIONS THAT MUST HAVE COMPUTER APPLICATIONS REQUIREMENTS IN MACARS AREAS
BASED UPON AN ANALYSIS OF ORGANIZATIONAL AND USER PROVIDED DATA

AREANAME	HEADCD 1	2	3	4	6	7	8	9	10	11	12	13	14	17	18	19	20	21	22	23	24	25	TOTA
AUTOMATIC TEST EQUIPMENT	1	1	1	.	.	.	1	.	.	1	1	1	1	.	1	.	.	.	1	1	1	1	13
CHEMISTRY	.	.	1	.	.	1	.	.	.	1	.	.	.	.	1	.	.	.	1	.	.	.	5
COMMAND AND CONTROL COMMUNICATIONS	.	1	1	.	.	.	.	.	.	1	1	1	1	.	1	.	.	.	.	1	1	.	9
COMPUTERS	1	1	1	1	1	1	1	.	.	1	.	1	1	1	1	1	.	1	1	1	1	.	17
CONFIGURATION MANAGEMENT	1	1	1	1	.	1	1	.	1	1	1	.	1	1	1	.	1	1	1	1	1	1	18
COST AND SCHEDULE ANALYSIS	1	1	1	1	1	1	1	1	.	1	1	1	.	1	1	.	1	1	1	1	1	1	19
ELECTRO-MAGNETIC RADIATION	.	1	1	.	.	.	1	.	.	1	.	.	1	.	1	.	.	.	.	1	1	1	9
ELECTRONIC COMPONENTS	.	1	1	.	.	1	1	.	.	1	.	.	1	.	1	.	.	.	1	1	1	1	11
FIRE CONTROL	.	1	1	.	.	1	1	.	.	1	1	1	1	.	1	.	.	.	1	.	.	1	11
GROUND SUPPORT EQUIPMENT	.	1	1	1	.	1	1	.	.	1	.	1	1	1	1	1	.	.	1	.	1	1	14
GUIDANCE AND CONTROL	1	1	1	1	.	1	1	.	.	1	1	1	1	.	1	.	.	.	1	.	1	1	14
HUMAN FACTOR ENGINEERING	.	1	1	1	.	1	1	.	.	1	.	.	.	.	1	.	.	.	1	.	1	1	10
INDUSTRIAL/MANAGEMENT ENGINEERING	.	1	1	1	.	1	1	.	.	1	.	.	1	1	1	1	1	1	1	1	1	1	16
LASERS	.	.	1	.	.	.	1	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	4
MATERIALS	.	1	1	.	.	.	1	.	.	1	.	.	1	.	1	.	.	.	1	.	.	.	7
MATHEMATICS	.	1	1	1	1	.	.	.	.	1	.	1	1	1	1	1	.	1	1	1	.	.	13
METROLOGY	.	.	1	.	.	.	.	.	.	1	.	1	1	.	1	1	.	.	.	1	.	.	7
MISSILE DYNAMICS	1	1	1	1	.	1	1	.	.	1	1	1	1	1	1	.	.	.	1	.	.	.	13
NUCLEAR EFFECTS	.	1	1	.	.	.	.	.	.	1	1	.	1	.	1	.	.	.	1	.	.	.	7
OPERATIONS RESEARCH	.	1	1	.	1	.	.	.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	17
OPTICS	.	1	1	.	.	.	1	.	.	1	.	.	1	.	.	.	.	.	.	.	.	1	6
PARTICAL BEAM	.	.	1	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	3
PRODUCT ASSURANCE	1	1	1	1	.	1	1	.	.	1	1	1	1	.	1	1	1	.	1	.	1	.	16
PROPULSION	1	.	1	1	.	1	1	.	.	1	1	.	1	.	1	.	.	.	1	.	.	1	11
RADAR	.	1	1	1	.	1	.	.	.	1	.	1	1	.	1	.	.	.	.	.	.	1	9
RISK ANALYSIS	1	1	1	1	.	1	.	.	.	1	.	1	1	1	1	.	.	1	1	1	1	1	15
SAFETY ENGINEERING AND MANAGEMENT	.	1	.	.	.	1	1	.	.	1	.	.	.	.	1	.	.	.	1	.	.	.	6
SEEKERS	.	.	1	1	.	.	1	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	6
SYSTEMS DESIGN AND DEVELOPEMENT	1	1	1	1	.	.	1	.	.	1	1	1	1	.	1	.	.	.	1	1	.	.	12
SYSTEMS SIMULATION	1	1	1	.	.	1	1	.	.	1	1	1	1	.	1	.	.	1	1	.	.	1	13
SYSTEMS	.	1	1	1	.	1	.	.	.	1	1	1	1	.	1	.	.	.	1	.	.	1	11
TARGETS	.	.	1	1	.	1	.	.	.	1	.	1	1	.	1	.	.	.	.	.	.	1	8
TELEMETRY	.	1	1	1	.	1	.	.	.	1	.	1	.	.	1	.	.	.	.	.	.	1	8
TEST AND EVALUATION	1	1	1	1	.	1	1	.	.	1	1	1	.	.	1	.	1	.	1	1	1	1	15
FACILITIES MANAGEMENT	.	1	.	1	.	1	.	.	.	1	.	.	1	.	.	.	.	.	1	.	.	.	6
INSTRUMENTATION	.	1	1	.	.	.	1	.	.	1	.	.	1	.	1	.	.	.	1	.	.	.	7
INFARED AND ELECTRO-OPTICAL SENSOR	.	1	1	1	.	.	1	.	.	1	1	1	1	.	.	.	.	.	.	.	.	1	9
STRUCTURES	.	.	1	1	.	1	1	.	.	1	1	1	1	.	1	.	.	.	1	.	.	.	10
ADMINISTRATIVE SUPPORT FOR ENGINEE	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
PUBLICATION PREPARATION	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	2
ELECTRICAL EQUIPMENT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
WARHEAD ENGINEERING	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
GENERAL ENGINEERING	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
BUDGET & ACCOUNTING	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
TECHNICAL PUBLICATIONS	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
TECHNICAL ILLUSTRATIONS	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
TOTAL	12	32	37	22	5	23	26	1	2	38	17	23	35	10	32	7	6	8	27	15	15	22	415

LEGEND FOR HEADCD

1.ADV MP WPN SYS PROJ OFC	2.AIR DEF COM/CON PROJ OFC	3.ARMY MISS LAB	4.CHAP/FAAR PROJ OFC
5.CIV OFC TNG MGT DIV	6.CMPT	7.HAWK PROJ OFC	8.HELLFIRE/GLD PROJ OFC
9.INT LOG SUPP OFC	10.INTMAT LOG DIR	11.JNT ATAC MISS PROJ OFC	12.JTACMS PROJ OFC
13.MGT INFO SYST DIR	14.MISS LOG CNTR	15.MISS SYS READ DIR	16.MLRS PROJ OFC
17.PATRIOT PROJ OFC	18.PERSHING PROJ OFC	19.PROD ASSUR DIR	20.STINGER PROJ OFC
21.SYST ANAL EVAL OFC	22.SYS-ENG PROD DIR	23.TMDE SUPP GR	24.TOW PROJ OFC
25.US ROLAND PROJ OFC			

Figure 2-53 Composite of MACARS Areas Supported by Computer Applications

NICOM SCIENTIFIC AND ENGINEERING COMPUTING REQUIREMENTS ANALYSIS
ORGANIZATIONS THAT HAVE COMPUTER APPLICATIONS REQUIREMENTS IN ENGINEERING AREAS
BASED UPON AN ANALYSIS OF ORGANIZATIONAL AND USER PROVIDED DATA

ENGEERINGNM	HEADCD 1	2	3	4	6	7	8	9	10	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTA
AEROSPACE AND AERONAUTICAL ENGINEE	1	.	1	.	.	.	1	.	.	1	1	.	.	1	.	1	1	1	.	1	.	.	1	11
CHEMICAL ENGINEERING	1	.	1	.	.	1	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	5
CIVIL ENGINEERING	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	2
COMPUTER SCIENCE	1	1	1	.	1	1	1	.	.	.	1	1	.	.	1	1	1	.	.	1	1	1	.	14
ELECTRICAL AND ELECTRONICS ENGINEE	1	1	1	.	.	1	1	.	.	1	.	1	.	1	.	1	1	1	.	1	1	1	1	15
FIRE PROTECTION ENGINEERING	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	2
HUMAN FACTORS ENGINEERING	1	1	.	.	.	.	1	.	.	.	.	.	.	.	.	1	1	.	.	1	1	1	.	8
INDUSTRIAL ENGINEERING	1	1	1	.	.	1	1	.	.	1	.	1	.	1	1	1	1	.	1	1	1	1	1	16
MATERIAL SCIENCE ENGINEERING	1	.	1	.	.	.	1	.	.	.	.	1	.	.	.	1	.	.	.	1	.	.	.	6
MECHANICAL ENGINEERING	1	1	1	.	.	1	1	.	.	1	1	1	.	.	.	1	1	1	.	1	1	1	1	15
MEDICAL ENGINEERING	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
NUCLEAR ENGINEERING	.	1	1	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	1	.	5
STRUCTURAL ENGINEERING	1	.	1	.	.	.	1	.	.	.	1	1	.	.	.	1	.	.	.	1	.	1	.	8
GENERAL ENGINEERING	.	1	1	1	.	1	1	.	.	.	1	.	1	1	1	.	.	1	.	1	1	.	1	13
LOGISTICS ENGINEERING	.	.	1	.	.	.	.	.	1	.	.	1	.	.	.	.	.	1	.	.	.	.	.	4
DATABASE MANAGEMENT	.	1	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	3
UNIVERSAL TEST EQUIPMENT	.	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	4
PROGRAM ANALYSIS	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
OPERATIONS RESEARCH ANALYSIS-COST	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	3
LASER MODELING	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	3
LASER PROPAGATION	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
PROJECT MANAGMENT RISK ANALYSIS	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	2
PHYSICS	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	3
ORSA SUPPORT-METROLOGY	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	2
MATH & STATISTICAL ANALYSIS	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	2
BUDGET AND ACCOUNTING	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	2
ELECTRONICS ENGINEERING	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
WEAPON SYSTEMS ANALYSIS	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	2
CONFIGURATION MANAGEMENT	.	.	.	.	.	1	1	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
LOGISTICS MANAGEMENT	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
COST ANALYSIS AND BUDGETING	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	2
ELECTRO-OPTICAL ANALYSIS	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
RADAR SPECIALIST	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
OPTICAL ENGINEERING	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	2
CHEMISTRY	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
PUBLICATION PREPARATION	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
VALUE ENGINEERING	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
FACILITIES ENGINEERING	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
MANUFACTURING ENGINEERING	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
INDUSTRIAL AUTOMATION ENGINEERING	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
IMAGE PROCESSING	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
PROPERTY MANAGEMENT	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
ANALYTICAL CHEMISTRY	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
TECHNOLOGY DATABASE MANAGEMENT	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	2
TECHNICAL ILLUSTRATIONS	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
RELIABILITY AVAILABILITY MAINTAINA	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
AUTOMATED CALIBRATION	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
RADAR	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
BUSINESS APPLICATIONS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
TOTAL	11	11	25	1	6	7	16	1	2	4	9	13	1	5	4	11	8	5	4	17	8	8	5	182

LEGEND FOR HEADCD

1.ADV MP WPN SYS PROJ OFC	2.AIR DEF CON/COM PROJ OFC	3.ARMY MISS LAB	4.CHAP/FAAR PROJ OFC
5.CIV OFC TNG MGT DIV	6.CMPT	7.HAWK PROJ OFC	8.HELLFIRE/GLD PROJ OFC
9.INT LOG SUPP OFC	10.INTNAT LOG DIR	11.JNT ATAC MISS PROJ OFC	12.JTACMS PROJ OFC
13.MGT INFO SYST DIR	14.MISS LOG CNTR	15.MISS SYS READ DIR	16.MLRS PROJ OFC
17.PATRIOT PROJ OFC	18.PERSHING PROJ OFC	19.PROD ASSUR DIR	20.STINGER PROJ OFC
21.SYST ANAL EVAL OFC	22.SYS-ENG PROD DIR	23.TMDE SUPP GR	24.TOW PROJ OFC
25.US ROLAND PROJ OFC			

Figure 2-54 Composite of Engineering Areas Supported by Computer Applications

ORGANIZATION OFFICE SYMBOL: AMSMI-R

ORGANIZATION NAME: ARMY MISSILE LABORATORIES

TYPES OF WORK AND ANALYSIS PERFORMED	DIRECTORATES AND OFFICES													
	RA	RB	RD	RE	RG	RH	RK	RL	RN	RO	RP	RR	RT	RX
Aerodynamics			x	x	x	x	x			x				
Aerophysics	x											x		
Administration											x			x
Aerospace Engineering										x				
Analog Computers			x				x	x						
Analysis	x	x	x		x	x	x	x	x	x				
Atmospheric Studies		x				x								
Battlefield Effects	x	x		x						x				
Battlefield Scenarios		x	x											
Battlefield Models	x	x												
Beam Studies										x		x		
Blast Effects		x								x			x	
Business Management	x													x
CADE/CAM									x					
Chemicals						x							x	
Chemistry							x					x		
Combat Support Systems	x	x								x				
Communications		x		x	x	x				x		x	x	
Computational Fluid Dynamics			x											
Computer Technology					x									
Configuration Management	x	x							x		x			x
Controls			x	x										
Cryogenics						x							x	
Databases	x	x	x				x	x	x	x	x			
Design		x												
Designators				x	x								x	
Directed Beam Studies						x								
Dynamics			x		x		x	x						
Electromagnetic Effects					x					x				
Electromagnetics				x		x						x		
Electro-Optics			x			x								
Electrical Engineering		x								x				
Electronics		x		x	x	x				x				
Engineering Analysis	x	x							x	x	x			
Environmental Effects		x		x						x				
Feedback & Controls					x									
Fluid Dynamics			x		x									
Financial Management	x										x			
Finite Elements			x				x	x						
Graphics		x							x					

Figure 2-55 Types of Work and Analyses Performed

TYPES OF WORK AND ANALYSIS PERFORMED	DIRECTORATES AND OFFICES													
	RA	RB	RD	RE	RG	RH	RK	RL	RN	RO	RP	RR	RT	RX
Ground Support Equipment		x						x						
Guidance and Controls		x		x	x									
Heat Transfer			x	x		x	x	x						
High Speed Photography								x						
High Vacuum Technology						x							x	
Holography								x				x		
Hybrid Computer			x											
Hydrocodes			x				x	x						
Hydrodynamics			x											
Industrial Engineering									x					
Instrumentation		x												
Inventory Control											x			
Lasers			x	x	x	x		x				x	x	
Launchers			x					x					x	
Lethality	x	x											x	
Logistics	x	x	x							x				
Liaison									x		x			
Library											x			
Magnetospheric Studies						x								
Manufacturing Engineering									x					
Materials				x		x	x	x				x		
Mathematics			x				x	x						
Managements Studies														x
Meteorology												x		
Missile Design	x							x						
Missile Dynamics								x						
Modelling	x		x		x	x	x	x						
Non-Destructive Testing								x						
Nuclear Effects	x			x		x					x	x	x	
Operations Research	x	x							x		x			x
Optical Data Processing												x		
Optics			x	x	x	x						x	x	
Orbital Mechanics						x								
Plume Dynamics							x							
Plume Studies			x				x							
Powered Trajectory Analysis							x							
Programming			x		x	x	x	x						
Project Managment	x													x
Propellants							x							

Figure 2-55 Types of Work and Analyses Performed (cont'd)

TYPES OF WORK AND ANALYSIS PERFORMED	DIRECTORATES AND OFFICES													
	RA	RB	RD	RE	RG	RH	RK	RL	RN	RO	RP	RR	RT	RX
Propulsion							x							
Radar				x	x	x						x		
Real-Time			x											
Reliability/ Maintainability Engineering		x												
Risk Analysis		x								x				
Rocket Motors							x							
Rotor Dynamics								x						
Seekers				x	x	x		x					x	
Sensors				x	x	x						x		
Signals				x										
Signatures			x	x										
Simulation			x		x	x	x	x		x				
Spreadsheet	x								x		x			x
Statics								x						
Statistics			x					x		x				
Storage Studies													x	
Structures			x					x						
Structural Dynamics								x						
Systems	x	x	x		x	x	x	x			x			x
Systems Engineering	x	x												x
Systems Performance Assessment	x	x								x				
Techniques	x	x			x				x					x
Telecommunications		x		x										
Test and Evaluation	x									x			x	
Testing													x	
Thermodynamics			x	x		x	x	x						
Trackers				x	x	x		x					x	
Trajectory Analysis (Aeroballistics)			x				x						x	
Vibrations								x					x	
Warhead and Fuze								x					x	
Wave Studies (EO,IR,UV,RF)			x	x	x	x						x	x	
Weather (Extreme Heat, Cold, etc.)								x					x	

Figure 2-55 Types of Work and Analyses Performed (cont'd)

TYPES OF WORK AND ANALYSES PERFORMED	SYSTEMS ENGINEERING AND PRODUCTION DIRECTORATE	PRODUCT ASSURANCE DIRECTORATE
Aerospace Engineering	x	x
Automation Engineering	x	
Business Management	x	
CADE/CAM	x	
Chemical Engineering		x
Combat Support Systems	x	
Communications	x	
Computer Science	x	x
Computers	x	
Configuration Management	x	
Database	x	x
Design	x	
Dynamics	x	
Electrical Engineering	x	x
Electronics	x	x
Engineering Analysis	x	
Financial Management	x	
Graphics	x	
Guidance and Controls		x
Heat Transfer	x	
Human Factors Engineering	x	x
Industrial Engineering	x	x
Instrumentation		x
Inventory Control	x	x
Logistics Engineering	x	
Manufacturing Engineering	x	
Materials	x	
Mechanical Engineering	x	x
Metrology		x
Missile Dynamics		x
Modelling	x	
Operations Research	x	x
Optics	x	
Product Assurance		x
Product Engineering	x	
Programming	x	
Project Management	x	
Quality Control Engineering		x
Radar		x
Reliability & Maintainability Engineering		x
Risk Analysis		x
Simulation	x	
Seekers		x
Spreadsheet	x	
Statistics	x	x

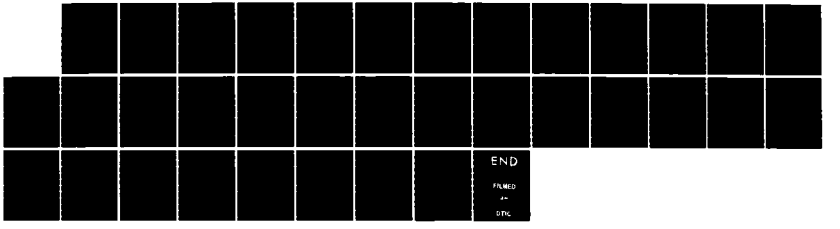
Figure 2-56 Types of Work and Analyses Performed

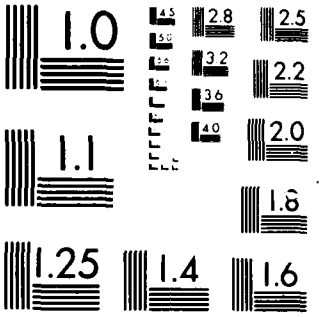
TYPES OF WORK AND ANALYSES PERFORMED	SYSTEMS ENGINEERING AND PRODUCTION DIRECTORATE	PRODUCT ASSURANCE DIRECTORATE
Structures	x	
Systems	x	
Systems Engineering	x	x
Systems Performance Assessment	x	x
Targets		x
Telemetry		x
Test and Evaluation	x	x
Test Equipment	x	

Figure 2-56 Types of Work and Analyses Performed (cont'd)

AD-A163 382 US ARMY MICOM SCIENTIFIC AND ENGINEERING SUPPORT COMPUTATIONAL CAPABILITI..(U) INTER SYSTEMS INC ANNANDALE VA F BULCAVAGE 15 NOV 85 DAAH03-85-C-0032 3/3

UNCLASSIFIED F/G 9/2 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

2.5.3 User Requirements

The S&E User Community requires a state-of-the-art Distributed Hierarchical Data Processing System that will make available supercomputer, mainframe, minicomputer and microcomputer processing power, to satisfy the immense variety of S&E Computing Applications Requirements that exist at MICOM. The Users need a wide variety of software packages and programming languages to support their Applications Requirements. They need more extensive training on the hardware, software and telecommunications capabilities that are made available for their use. They need an S&E Computing Environment that is TOTALLY SUPPORTED and TOTALLY MAINTAINED at a STATE-OF-THE-ART status on a TURNKEY BASIS. Some more specific needs are identified below:

- Less expensive mainframe computer support from IMD
- Faster mainframes, minis and micros and more central memory at all levels of computers
- Operating Systems that run across levels of hardware and across different Vendor's machines (i.e., UNIX)
- More terminals and CAD Workstations
- More minis and micros
- Software packages that are available across levels of hardware and across different Vendor's machines
- Access to a Supercomputer
- Better support from IMD
- Office Automation hardware and software
- Local Area Networks
- Secure Communications both on and off the Arsenal
- More contractor support

- Better equipment maintenance support
- Faster way to acquire hardware and software
- Consulting services (hardware, software and telecommunications)
- Assistance in determining ADP requirements
- More programming and more software package support
- Better supply mechanisms for ADP related supplies and better quality ADP supplies (computer paper, floppies, printer wheels and ribbons, plotter pens and paper, etc.)
- Locally provided training, tailored to User's work area
- Wider access to PLATO for training purposes
- Need somewhere to go when technical problems arise and receive responsive help
- Need high-resolution color graphics hardware and software support
- Need mainframe hardware that is at least eight times faster than the mainframes that are currently available at the Central Facility
- Need eight to sixteen megabytes of central memory on the new mainframes
- Need faster communications line speeds for large file transfers between mainframes and minis

2.5.4 Training Requirements

The training requirements that exist at MICOM in the ADP area are vast. Over the next ten years, at least half to three-quarters of the 9,000 civilian and military personnel on the Arsenal should have extensive ADP training provided to them. A substantial computer literacy problems exists at MICOM that can only be rectified by a comprehensive training program directed at all levels of management, all levels of technical staff, and, all levels of support staff. Figure 2-57 shows an aggregation of the data provided on the Organizational Level Questionnaires regarding training requirements. Some training requirements were identified in twenty different areas; and, some additional estimates were made based upon further interviews with the User Community. Figure 2-57 should be treated only as a baseline of the training requirements that exist in each category. It shows only the number of individuals that need training in each category. Many individuals need training in many software packages, in many software categories. Many individuals will need beginner, intermediate and advanced training in many areas, over the long-term. The Command uses or plans to use at least 220 different software packages. Most of the demands for training are related to software packages, programming languages, and fundamental use of the computer as tools for the work environment. Over the next decade, it is estimated that hundreds of thousands of training units are required to properly develop the MICOM Computer User Community. This requirement can be accomplished through the development of a local, permanently staffed Demonstration and Training Facility, along with extensive use of PLATO for delivery of training units.

	TABULATED # OF INDIVIDUALS			ADDITIONAL ESTIMATES # INDIVIDUALS		
	CURRENT	NEAR TERM	LONG TERM	CURRENT	NEAR TERM	LONG TERM
Database Management Systems	240	585	194	387	247	770
Science & Engineering Packages	199	229	208	54	35	65
Graphics	59	63	60	137	137	148
Programming Languages	1324	1541	1343	287	204	538
Project Management Packages	134	165	148	141	137	204
Scientific Software Libraries & Codes	0	0	0	59	63	62
Statistical & Financial Packages	36	38	36	8	7	9
Simulation/Modeling	45	54	42	60	62	135
Personal Computer Communications	14	12	11	54	84	84
Word Processing Packages	138	127	86	38	66	121
CAD/CAM & Factory Automation	98	111	100	0	0	30
Operating Systems, Maintenance, Troubleshooting & Systems Integration	203	244	204	225	234	389
Telecommunications & Networking	150	190	206	246	267	341
Microcomputer Training, Terminal Training, Minicomputer Training, Accessing Mainframe, & JCL	173	310	176	260	235	405
Spreadsheet	89	103	81	18	21	66
Canned Software Application Packages (nonspecific S&E & Business)	1164	1304	1320	190	168	319
Tailored Software Application (S&E & Business)	1128	1276	1292	210	198	319
Math Analysis Techniques	59	62	67	17	22	22
Subject Matter	172	169	136	112	163	235
General ADP Orientation (for Users & Non-Users)	198	206	208	222	248	265
	5623	6789	5918	2725	2598	4527

Figure 2-57 Estimates of the Number of Individuals Needing Training

2.5.5 Support Requirements

In addition to the mainframe support requirements that exist for supporting the Central S&E Computing Facility, there is a great need for more support out in the various organization's own small computing centers. There exists large DEC VAX and HP User groups, that are not well supported by IMD according to the Users and Organizations surveyed. The Users Community would like to see IMD develop and provide support for these large User Communities. The Users would like IMD to provide, as a turnkey service: hardware, software and peripherals for these systems, upgrades to existing systems (memory, channels, ports, CPUs, disk, tape, etc.), hardware and software maintenance, operations and systems support, and networking of these systems, to name a few. Basically, the Users want the same level of support that is provided for the central computing facility, at the remotely located organizational computing centers. In other words, TOTAL TURNKEY SUPPORT is required for the Command's ADP hardware, software and telecommunications needs.

2.5.6 System Integration Requirements

MICOM faces some very complicated system integration requirements. Over the next decade there will exist thousands of terminals, thousands of microcomputers, hundreds of minicomputers, a number of mainframes, and maybe even a supercomputer. In addition, there will be hundreds of local printers, many high-speed printers, hundreds of plotters and countless other peripheral devices, that the Users want "hooked-up" to a communications network. It is likely that two independent networks will be required: one for secure and one for unsecure access requirements. Currently MICOM uses equipment from over a hundred different hardware vendors. The Users think that it is very easy to just "hook-up" all these pieces of equipment on a local area network and all their communications needs will be satisfied. Emerging current and future technology will make this wish possible, but not without some careful analysis of the system compatibility requirements that will facilitate the integration of all the different hardware into a coherent system. An Integrated Data Communications Utility Network can be designed as the system integration medium to allow all of these different systems to "talk" to each other.

2.5.7 System Conversion Requirements

The Users indicated that there are millions of lines of S&E code that have been developed for the CDC machine. If the mainframe CDC computers are replaced with a brand X computer, a significant code conversion problem will exist. The exact number of programs and lines of code, that would have to be converted, did not surface during the course of this study. A significant data conversion exercise would have to take place to convert data tapes in a 60-bit binary word format to an ASCII or EBCDIC character format for data transfer. The S&E tape library contains tens of thousands of tapes, and thus, there would exist a substantial data conversion requirement, if the replacement mainframe is brand X. Many applications are dependent upon the CDC versions of the programming languages, and many third party software packages. Applications dependent upon CDC provided packages would have to be totally reworked using some other Vendor's software packages. Depending upon the actual number of codes and applications that would require conversion or reworking, the conversion effort conceivably could take from one to two years, and cost the Command potentially millions of dollars in conversion costs. More detailed conversion requirements could not be developed using the data collected. A more detailed conversion analysis should be performed in the future to more accurately assess the magnitude of the potential conversion requirements.

2.5.8 Telecommunications Requirements

The growing number of Computer Users, computers, terminals and peripheral devices will create a substantial telecommunications requirement over the next decade. The Users want a network created that will permit them to access multiple computers at MICOM; and, also provide gateways to other networks. Organizations want their own local area networks; and then, want their local area networks to talk to other local area networks. They also want access to both the S&E and Business Centers Host Computers from the same terminal. Networking support is required for: CDCNET, IBMSNA, DECNET, HP ADVANCENET, SPERRYLINK and various other Vendor's networking software systems. Support is needed for: CDC UT 200, HASP Multi-Leaving, 2780/3780, 3270 BSC, SDLC, HDLC, ETHERNET, OPENNET, X.25, UNISCOPE and a variety of other Vendor unique communications technologies.

Both dedicated and dial-up circuits are required at various line speeds. Dedicated lines are normally needed from 2400 through 9600 BAUD. Dial-up lines are needed from 300 through 9600 BAUD. Some future requirements exist for 19.2 KB and 50.2 KB circuits, and for some 1 GB satellite links. Local area networks are needed with speeds up to 10 MBPS. Megabyte and Gigabyte Data links will become commonplace requirements, over the next ten years. High-speed fiber optics data links can be used to satisfy some of these telecommunications requirements on the Arsenal, as this technology expands and the implementation costs drop.

2.5.9 Hardware Requirements

The Command has extensive needs for multiple levels of computers including Mainframes, Minicomputers, Microcomputers and Supercomputers. A Scientific and Engineering Computing Environment needs to be created with an appropriate mix of levels of computing power, that will provide satisfactory response times for all interactive computer work and reasonable turn-around times for all batch processing. Sufficient quantities of both centralized and decentralized computing power must be made available to the S&E User Community.

The centralized mainframe machines must be configured with sufficient central memory, communications ports, disk, tape, printers and other equipment to support 300-500 simultaneous Users. A multiple-processor configuration is necessary to segregate the interactive and batch workloads. Distributed mainframes and minicomputers need to be appropriately configured to meet the Users response-time requirements. Supercomputer requirements in the near-term can be satisfied on the Army Supercomputer Network, unless MICOM can justify getting a Supercomputer for S&E Requirements, NOW.

The new central mainframe computer(s) will need a minimum of 8 Megabytes of Central memory with ample room for expansion of central memory, as the need arises. At least two large mainframes in the 30-60 MIP range are required as a starting point for developing a state-of-the-art computing environment. A supercomputer in the 100 MIP or above class will be required in the future. A network of ten to twelve medium-sized mainframes, in the 5-20 MIP class, will be a cost-effective way to replace aging minicomputer configurations.

The computer hardware is available to meet MICOM's S&E Computing

Requirements in a cost-effective and forward-looking manner, if only MICOM organizations can learn to work together in meeting their computing needs.

2.5.10 Software Requirements

The Central Computing facility must acquire and support software packages in all the software category areas outlined in Section 2.5.1. IMD must review the software packages identified in Figure 2-5 in Section 2.1.2; and, begin to evaluate the capabilities of the packages identified by category and decide which packages should be acquired and supported at the Central Facility. IMD must also seek out information on and evaluate other software packages that might meet some of the User's needs. A detailed study should be performed to determine the best mix of software packages to acquire for the central facility. Extra consideration should be given to software packages that run on a mix of machines that are used by MICOM, to improve the level of support that IMD can provide in the area of software packages.

Many of the software packages, that the User Community is interested in, require large amounts of central memory and very fast CPU speeds to provide reasonable response times to the Users. Therefore, a Virtual Operating System is required to support a large number of Users, who will simultaneously need to interactively execute large-core requirement programs. The Virtual Operating System must comfortably support about 300-500 interactive Users concurrently with very little degradation in response time. It must also support both interactive and batch processing, concurrently.

Throughout MICOM, there is a great need for a mechanism to provide software packages to the User Community for use on their minicomputers and microcomputers. IMD could be providing software package acquisition services to all MICOM organizations, in a similar fashion to what is being done through

the INTEL Procurement. Too much valuable engineering manpower resources are spent developing software capabilities, that could be readily purchased off-the-shelf!

2.6 A Quantification of the Equipment Requirements

This section provides some quantification and estimated costs information on MICOM'S organization's perceptions of what their equipment acquisition requirements are for the next ten years. The equipment information was developed by aggregating the data, provided on the Organizational Level Questionnaires, regarding the acquisition of mainframes, minicomputers, microcomputers, word processors and terminals. Hardware and software life cycle acquisition costs were estimated by ISI. Other related equipment acquisition requirements are also discussed.

2.6.1 Mainframes

Figure 2-58 shows the aggregation of the Hardware Inventory and Acquisition Plans that were provided by the 25 organizations that participated in this study effort. The data collected indicated that one mainframe computer system was required for the Central Computing Facility to replace the existing mainframes. It is likely that a single CPU mainframe configuration will be inadequate to meet the growing needs of the S&E Community. Therefore, a dual CPU configuration is recommended as an interim replacement configuration, for the existing CDC 6600 and CYBER 74 mainframes. If sufficient funds are not available for a dual processor configuration now, then a mandatory requirement for the replacement configuration should be that it can be augmented with a second processor in the future. This dual processor concept facilitates the separation of the interactive and batch computing workloads, which is essential to meeting the system performance requirements of the User Community. An adequate dual CPU configuration will cost about 3.2 to 6.2 million dollars to purchase. Life cycle hardware maintenance costs are estimated to be between 1.3 and 2.8 million dollars.

CURRENT INVENTORY AND FISCAL YEAR PLANNED ADPE ACQUISITIONS

EQUIPMENT	85	86	87	88	89	90	91	92	93	94	TOTAL	# ADDED FY86-94
MAINFRAMES	19	1	0	0	0	0	0	0	0	0	20	1
MINICOMPUTERS	73	33	23	6	7	1	0	2	0	0	145	72
MICROCOMPUTERS	349	440	203	87	92	13	23	13	15	46	1,281	932
WORD PROCESSORS	119	23	18	7	9	4	1	1	1	1	184	65
TERMINALS	437	130	44	12	15	8	9	8	8	8	679	242

Figure 2-58 Hardware Inventory And Acquisition Plans

Using an average software package cost of $100,000 and assuming a need for twenty packages exists, a 2 million dollar software acquisition cost will be incurred. Assuming a 10% annual software maintenance cost and that ten packages will be acquired immediately, yields a life cycle acquisition and maintenance cost estimate of 2 million dollars for 10 software packages. Subsequently, if twenty software packages are needed, a 4 million dollar software expenditure should be expected. Thus, a new central mainframe configuration will cost somewhere between 8.5 and 13 million dollars, over the ten-year life cycle.

Over the long-term, a network of mainframes should be considered as a cost-effective mechanism for satisfying the growing computing needs of the S&E Community. A network consisting of approximately 10-12 mainframes, would be capable of adequately supporting the total general purpose S&E computing workload. Eventually, the network of mainframes should be augmented, with sufficient supercomputer computing power, to handle the supercomputer workload, that will be generated by a Supercomputer User Community consisting of approximately 175 individuals.

2.6.2 Minicomputers

Figure 2-58 also shows that, by the end of FY 85, there will be 73 minicomputers on the Arsenal. Over the next ten years, plans exist to acquire an additional 72 minicomputers. With the advent of the Department of the Army Minicomputer Buy, it is expected that the number of minicomputers acquired could double to 144. The purchase cost for these minicomputers is estimated to be between 43.2 and 86.4 million dollars (assuming an average life cycle hardware configuration cost of $600,000 per minicomputer system) for hardware; and, the life cycle software package acquisition and maintenance costs for these systems are estimated to be between 72 and 144 million dollars (assuming an average software package acquisition cost of $50,000, a need for ten different packages, and a 10% annual software maintenance fee, which yields a $500,000 purchase cost and a $500,000 life cycle maintenance cost, over a ten-year period). MICOM will spend somewhere between 115.2 and 230.4 million dollars on minicomputer related ADPE expenditures, over the next ten years. Using a 40% life cycle maintenance cost estimation factor would introduce somewhere between 17.28 and 34.56 million dollars into the life cycle cost model for MICOM minicomputers. This brings the total life cycle cost estimate for minicomputers to between 132.48 and 264.96 million dollars.

Using the 13 million dollar life cycle cost figure developed for the central mainframe configuration as a frame of reference, MICOM could have between 10 and 20 mainframe configurations for the same amount of money that will be spent on minicomputers alone. Clearly, top management needs to analyze this situation and pursue a more cost-effective means for providing adequate computing resources to the S&E Community.

2.6.3 Microcomputers

Figure 2-58 also shows that, by the end of FY 85, there will be 349 microcomputers on the Arsenal. Indications are strong that about 200 more micros already exist on the Arsenal and that another 932 will be required in the future. There are two types of microcomputers that are being acquired: one type is a multi-user super microcomputer and the other type is a single-user personal computer (PC) microcomputer. It is anticipated that between 450 and 600 super microcomputers will be acquired at an average life cycle configuration acquisition cost of $60,000. This yields a super microcomputer acquisition cost estimate between 27 and 36 million dollars. It is anticipated that between 482 and 2,000 personal computers will be acquired at an average life cycle configuration acquisition cost of $15,000. This yields a personal computer configuration life cycle acquisition cost estimate between 7.23 and 30 million dollars. Software package acquisition and maintenance life cycle costs are estimated at $30,000 for the super microcomputers and $10,000 for the personal computers. This yields a software cost estimate between 13.5 and 18 million dollars for the super microcomputers and a 4.82 to 20 million dollar software cost estimate for personal computers. MICOM will spend between 52.55 and 104 million dollars to purchase microcomputers, over the next ten years. This is enough money to acquire between 4 and 8 mainframe dual CPU configurations. Microcomputer configuration maintenance costs are estimated at between 10.8 and 14.4 million dollars for the super microcomputers and between 2.892 and 12.0 million dollars for the personal microcomputers.

2.6.4 Word Processing

Figure 2-58 also shows that, by the end of FY 85, there will be 119 word processors on the Arsenal. Organizations indicated plans to acquire an additional 65 word processor configurations, over the next ten years. It is anticipated that up to 200 word processor configurations will be required, over the long-term. An average of $15,000 per word processor configuration was used to develop acquisition cost estimates, between $975,000 and $3,000,000. These estimates could double or triple depending upon the vendors selected and "TEMPEST" requirements. These estimates deal with "dedicated" word processing configurations; and, do not include general purpose stand-alone microcomputers, that may have word processing software packages installed on them.

The expected numbers of word processors, coupled with the large numbers of stand-alone microcomputers, should adequately meet the word processing needs of the Command, over the next ten years. But, compatibility problems will exist, between the word processor's software and the software used for word processing on the stand-alone microcomputers, for some time to come. Eventually, some hardware and software standards for word processing and text processing will evolve to address the compatibility problem. If these standards do evolve, MICOM may completely replace all the existing word processing equipment, which would also increase the estimated costs.

The word processors will need to be connected to local area networks to facilitate document exchange between organizations. Modems will need to be provided, along with communications lines, until local area networks are available for document transmission. Word processors and microcomputers will generate a large telecommunications traffic requirement, over the long-term.

2.6.5 Terminals

Figure 2-58 also shows that, by the end of FY 85, there will be 437 terminals on the Arsenal. Over the next ten years, plans exist to acquire an additional 242 terminals. Figure 2-8, in Section 2.1.5, showed the existence of at least 1405 other terminals. About 400-600 of these terminals are very old and should be replaced during the next two years. The total demand for terminals for the S&E Community, over the next ten years, is estimated at 1500 terminals. It is expected that microprocessor based engineering workstations will satisfy the remainder of the "terminal" needs of the S&E Users. The Intel Buy is being used to satisfy some of the terminal demands of the S&E Users, but it will not satisfy the advanced engineering workstation needs of the Users. The "engineering terminal" needs were included in the microcomputer category. Thus, an average cost of $500 per terminal is adequate for cost estimation purposes. Using this factor, MICOM will spend between $121,000 and $750,000 on terminal purchases, over the next ten years. But, if more expensive very high-resolution Color Graphics Terminals are acquired, a cost factor of $3,000 per terminal is more appropriate, and the estimated terminal purchase cost could approach 4.5 million dollars. Many graphics terminals will be acquired through the Intel Buy, due to the Tektronix emulation and compatibility features of the C.ITOH CRT and Color Graphics Terminals.

Terminals do not make a significant impact on the total anticipated ADPE expenditures for MICOM, over the next ten years, when compared to the potential expenditures on minis and micros.

2.6.6 Other Equipment

The S&E Community at MICOM uses a variety of scientific and engineering instruments for a variety of test and measurement activities. These include, but are not limited to:

- o RF and Microwave Measurement
- o Logic and Processor-Based Circuit Analysis
- o Digital Signal Analysis (Fourier)
- o Data Acquisition, Control and Test
- o Telecommunications and Data Communications Test and Evaluation
- o Process Control.

These activities are an integral part of R&D laboratory and industrial automation applications. Most of this testing and measurement activity is done in real-time, although much activity is also geared towards analysis of samples. Both digital and analog computers are used extensively to interface with a variety of scientific and engineering instrumentation. The computers utilized as part of these test and measurement systems are capable of performing general purpose computing, but are normally used as integral parts of highly specialized test and measurement applications.

In addition to the general computing needs of the Command, IMD should be providing more support to the laboratory automation and industrial automation computing requirements. IMD could be providing turnkey system acquisition and support services for the special purpose application areas. Further analysis of the laboratory automation and industrial automation requirements should be performed in a separate study.

2.6.7 Equipment Cost Summary

Figure 2-59 shows the life cycle cost estimates for MICOM ADP, over the next ten years. The low-end quantities reflect the data collected during the survey; and, the high-end quantities reflect the potential impacts of the DA minicomputer and microcomputer buys.

An analysis of the life cycle cost estimates shows:

- that a disproportionate amount of dollars will be spent on minis and micros,
- hardware acquisition costs for minis and micros seem reasonable at first, but when life cycle hardware maintenance and software acquisition and maintenance costs are added to the computations, the total costs for minis and micros become excessive,
- the cost of terminals, even very fancy color terminals, are very cheap when compared to microcomputer configuration costs,
- A total system, which would provide adequate computing capabilities well into the late 1990s, could be designed, implemented, operated, and maintained for 100 to 200 million dollars less than MICOM will spend if current trends continue.

MICOM HARDWARE AND SOFTWARE LIFE CYCLE COST ESTIMATES

ADPE EQUIPMENT CATEGORY	QUANTITY	LIFE CYCLE ACQUISITION COSTS	LIFE CYCLE MAINTENANCE COSTS	LIFE CYCLE SOFTWARE ACQUISITION AND MAINTENANCE COSTS	LIFE CYCLE HARDWARE AND SOFTWARE COSTS
MAINFRAMES	1 - 2	$ 3,200,000 - 6,200,000	$ 1,300,000 - 2,800,000	$ 2,000,000 - 4,000,000	$ 6,500,000 - 13,000,000
MINI	72 - 144	43,200,000 - 86,400,000	17,280,000 - 34,560,000	72,000,000 - 144,000,000	132,480,000 - 264,960,000
SUPER MICRO	450 - 600	27,000,000 - 36,000,000	10,800,000 - 14,400,000	13,500,000 - 18,000,000	51,300,000 - 68,400,000
PERSONAL MICRO	482 - 2000	7,230,000 - 30,000,000	2,892,000 - 12,000,000	4,820,000 - 20,000,000	14,942,000 - 62,000,000
		$ 80,630,000 - 158,600,000	$ 32,272,000 - 63,760,000	$ 92,320,000 - 186,000,000	$ 205,222,000 - 408,360,000
WORD PROCESSING	65 - 200	975,000 - 3,000,000	390,000 - 1,200,000	N/A	1,365,000 - 4,200,000
TERMINALS	242 - 1500	121,000 - 750,000	48,400 - 300,000	N/A	169,400 - 1,050,000
or TERMINALS	242 - 1500	726,000 - 4,500,000	290,400 - 1,800,000	N/A	1,016,400 - 6,300,000

Figure 2-59 MICOM ADP Hardware and Software Life Cycle Cost Estimates

3.0 System Implementation Alternatives

There are basically three conceptual alternatives for implementing a major MICOM Scientific and Engineering Computing System. They are Total Centralization, Total Decentralization and a Distributed Hierarchical Data Processing System. Under Total Centralization, all of the major computing power resides in one central location. Everybody is forced to use the central facility, with no exceptions. Users are provided with all the peripherals they need: graphics terminals, printers, plotters, CAD Workstations, etc. All of the equipment provided to the Users is connected via a network to the central computers. Under the Total Decentralization concept, major computing resources are freely distributed to all organizations, who desire it and can afford it. Each organization would then be responsible for meeting their own ADP needs. They would also be responsible for supporting their own Users. The need for a central computing facility vanishes, along with the people to run it, and the people necessary to support the Users. The Distributed Hierarchical Data Processing System approach recognizes the need for both centralized and decentralized computing capabilities. A carefully designed, controlled, and distributed mix of supercomputers, mainframes, minicomputers and microcomputers is both a feasible and cost-effective way to meet the TOTAL S&E Computing Requirements, well into the late 1990s.

From a life cycle hardware acquisition, maintenance and operations cost perspective, the Total Centralization concept ranks as the least costly alternative. The Total Decentralization concept ranks as the most costly alternative; and, the Distributed Hierarchical Data Processing concept ranks as the mid-road cost alternative. But, in properly designing a total system, the telecommunications networking alternatives can have a significant impact

upon the cost of the total system. MICOM must design the S&E Computing System to be cost-effective from a total system cost perspective, which must include life cycle costs for the hardware, software and telecommunications components of the total system. In addition, the total system must be responsive to the User's Requirements.

3.1 Alternative One-Total Centralization

A totally centralized computing system could be created to meet the needs of the S&E Community. A center could be created using a single or multiple vendor approach, combined with single or multiple levels of computing power (i.e., supercomputers, mainframes and minicomputers). The center would house the largest/most powerful computers from a variety of vendors. The center would contain computers to satisfy every need. The need for organizations to have their own computers vanishes. The center's operation would have to mirror the operation of a commercial timesharing company. System availability and response time would have to be a top management priority.

This approach would minimize incurred computer acquisition costs, maintenance and operations costs, and software package acquisition and maintenance costs. The actual design of the system would require substantially more data on the actual number of Computer Users and more technical computer workload information than was provided for this study, across all organizations. Otherwise, a poorly sized computing capability would result in replication of the workload management problems, which occurred during 1978-1980, when 500-600 Users saturated the Central Computing Facility Mainframes.

3.2 Alternative Two-Total Decentralization

A totally decentralized computing system could be created to meet the needs of the S&E Community. Each organization could obtain all the computers that they need. Each organization would be held responsible for meeting their own computing needs and supporting their Computer Users. Extraordinary computing requirements could always be satisifed by commercial timesharing arrangements, at a premium cost.

The major problem with this approach is that it is the most expensive way to go about satisfying the needs of the Users. Another problem is that the larger organizations with large budgets can afford to get the types of computers they need. The smaller organizations with smaller budgets are not likely to be able to afford adequate computing equipment. Naturally, the smaller organizations can piggy-back onto the computing resources of the larger organizations, but the guarantee of availability cannot be made.

MICOM needs vast amounts of computing resources, but the Total Decentralization approach is simply not a cost-effective way to meet the Total S&E Computing Requirements. MICOM continues to acquire many minicomputers that facilitate the procurement thresholds, but do not meet the needs of the End-Users.

3.3 Alternative Three-Distributed Hierarchy

A Distributed Hierarchical Data Processing System should be created to meet the expanding needs of the Scientific and Engineering Community at MICOM. A properly designed and controlled mix of supercomputers, mainframes, minicomputers and microcomputers would adequately meet the expanding needs of the Users, well into the late 1990s. An optimized mix of computers connected by a well designed Integrated Data Communications Utility Network would solve MICOM's S&E Computing Problems.

This approach takes advantage of the benefits of both centralized and decentralized processing concepts. It attempts to minimize the total system acquisition, maintenance, operations and support costs, but avoids the workload management problems of centralized system that utilizes only one or two large computers. The total workload is managed across a network of mainframes that support access to a supercomputer. Proper distribution of computing resources can also minimize telecommunications networking operations, maintenance and support costs.

The total cost of this approach will be 100 to 200 million dollars cheaper than the direction that MICOM is currently heading into, which is towards Total Decentralization (at a cost of between 205.22 and 408.36 million dollars). The Distributed Hierarchical Data Processing System would consist of one supercomputer, two large mainframe computers serving as front-ends into the supercomputers, about ten to twelve mainframes, and about 2000 microcomputers. These fifteen computers would be networked to approximately fifty minicomputers and up to 1500 terminals.

The supercomputer and the two front-end mainframes would be the Central Computing Facility. The ten to twelve mainframes or maybe just five or six larger mainframes would be distributed at strategic locations throughout the Command. A high-speed backbone network would connect the machines. Other computers and terminals would be organized into local area networks and have gateways into the backbone network.

This system could be configured to handle the Total S&E Computing Requirements in a cost-effective fashion. The only problem is getting all MICOM organizations interested in satisfying their ADP needs in a manner that is cost-effective across all organizations at the Command Level. What organizations perceive is cost-effective for them, may not be cost-effective for the command as a whole. Top Command management needs to make a decision that is technically sound and cost-effective at the Command Level.

4.0 Recommendations

4.1 Direction to Pursue

MICOM must develop a long-range plan and implementation strategy to meet the growing computer needs of the Scientific and Engineering Community. The S&E users must have access to a mix of computers including microcomputers, mini-computers, mainframes and supercomputers. The mix of computers must be integrated into a coherent integrated system and be interconnected by a telecommunications network. The recommended concept is to pursue the creation of a Distributed Hierarchical Data Processing System, which will consist of a controlled mix of supercomputers, mainframes, mini-computers and microcomputers designed to address the TOTAL S&E REQUIREMENTS. An Integrated Data Communications Utility Network must be designed and implemented to interconnect all levels of computers and various levels of local area networks on the Arsenal. The Network and Distributed Hierarchical Data Processing System must be designed, procured, installed, operated, maintained and supported on a TURNKEY BASIS. Management of the Network and Distributed Computer System must be centralized. The Total S&E Computing Environment must be designed to facilitate the total S&E Computing Needs, well into the late 1990s.

Such a system can be designed, implemented, operated and maintained for 100-200 million dollars less than MICOM will spend, if current trends towards total decentralization are permitted to continue. Such a system would facilitate TOTAL S&E Workload Management at a significant cost savings and it will provide more than adequate computing capabilities to the S&E Community.

The distributed computer system must support a rich variety of software

packages in the following areas: DATABASE MANAGEMENT SYSTEMS, ENGINEERING PACKAGES, GRAPHICS PACKAGES, PROGRAMMING LANGUAGES, PROJECT MANAGEMENT PACKAGES, SCIENTIFIC SOFTWARE LIBRARIES AND CODES, STATISTICAL PACKAGES, SIMULATION/MODELING PACKAGES, P.C. COMMUNICATIONS PACKAGES, WORD PROCESSING PACKAGES, and CAD/CAM and FACTORY AUTOMATION. These areas must be supported across levels of hardware: micro, mini, mainframe and supercomputer.

IMD needs to expand and improve the areas of service it provides in terms of hardware, software, telecommunications, consulting, programming, training and End-User services. IMD needs to become a provider of TURNKEY SOLUTIONS to the S&E User's ADP Requirements. IMD needs to design, implement, operate, maintain and support a state-of-the-art Scientific and Engineering Computing System that addresses the TOTAL S&E Computing Requirements, in a cost-effective and forward-looking manner.

4.2 Current Recommendations

As an interim solution to the current S&E Computing Problems (i.e., lack of sufficient central memory and adequate central processor speed), the existing mainframes and selected peripherals must be replaced IMMEDIATELY. A contract vehicle needs to be developed to accomplish this activity as soon as possible. The contract vehicle must include equipment acquisition, installation, maintenance and analyst support services. An additional contract vehicle is required to procure End-User equipment acquisition, installation, training, maintenance, User support and consulting services. A third contract vehicle is required to procure turnkey software support services to include: software studies, software acquisition, installation, testing, analysis, demonstration to the User Community, training, User support and consultation services in determining which software packages a User should use for their particular application and on which level and type of hardware their application should be executed on. This vehicle can be used to deliver software packages to the End-Users, as a service of IMD. Additional recommended activities are presented in the discussion of Phase I of the Master Plan and Implementation Strategy which is contained in the Management Overview document.

IMD and the Career Development Center Management need to work together, and establish a local Demonstration and Training Facility. Equipment should be acquired to facilitate training activities. A contractor should be acquired to provide local turnkey training services. Customized training programs should be developed for the User Community.

IMD needs to expand and improve the areas of service that it currently provides; and decisions, about the future scope of services, need to be made. IMD needs to develop a foundation upon which to build a TOTAL TURNKEY SUPPORT capability. These activities will help to bring about a standard method of operation and support for the S&E Community.

IMD needs to further study and develop preliminary design alternatives for the Distributed Hierarchical Data Processing System and the Integrated Data Communications Utility Network. The preliminary design should determine the structure of the Central Computing Facility and the Distributed Processing Centers, along with the overall networking topology strategy. A detailed system implementation plan and cost estimate must be developed.

4.3 Near-Term Recommendations

IMD needs to review the preliminary design, detailed system implementation plan and cost estimate for the Distributed Hierarchical Data Processing System and the Integrated Data Communications Utility Network. The design of the system must be finalized by the end of the first year and implementation activities should begin during the second year. During the second and third years, two Remote Processing Centers would be networked into the Central Computing Facility, creating a three node pilot backbone network. During the fourth and fifth years, one or two processing nodes would be added to backbone network each year. Thus, within five years the major processing nodes of the network will be operational. Local area networks will be created in parallel to the creation of the major system and integration of the local area networks into the backbone network will occur as required. The implementation schedule can be adjusted to accelerate the implementation of the system, as a function of available funding.

In parallel to these activities, IMD must finalize plans to augment the MICOM S&E Computing Environment with a Hardware Vector Processing Capability (i.e., a Supercomputer). The Supercomputer should be located in the Central Computing Facility to minimize additional operations and facilities costs. IMD needs to develop a contract vehicle to obtain, operate, maintain and support a Supercomputer for the MICOM S&E Community. The size and type of Supercomputer needed should be determined by a contractor performed requirements analysis. The requirements analysis should be performed during the fourth or fifth year and the Supercomputer should be operational by the end of sixth or seventh year.

4.4 Long-Term Recommendations

IMD must actively pursue and seek out new technologies to maintain the MICOM S&E Computing Environment at state-of-the-art. New technology must be investigated and evaluated for potential benefits to the S&E Community. As promising hardware, software and telecommunications technologies emerge and mature, IMD should temporarily access or acquire the new technology, test and evaluate the capabilities and demonstrate the capabilities to the User Community. If the Users are interested, the capabilities should be integrated into the S&E Computing Environment for the benefit of the Users.

IMD should be providing TURNKEY SOLUTIONS to the User's ADP needs. If IMD develops the capability to provide TURNKEY SERVICES, the Users will look to IMD for solutions to their problems, instead of viewing IMD as being one of their problems. IMD needs to provide TOTAL SUPPORT to the S&E Community.

Additional requirements, recommendations and an overall Master Plan and Implementation Strategy are discussed in the Volume I Management Overview document and the Executive Summary.

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